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PREFACE.

WHILE the Preface forms the first part of every work, as the name implies, and precedes always the descriptive matter, it is as invariably the last which is written, and the last often to be read.

Nevertheless there are few portions of a work the enditing of which is undertaken with more alacrity than the writing of this same preface — the author's mind being cheered by the near prospect of the completion of his task — it may be of a difficult and an arduous task — in which the obstacles to its successful issue were many, and the result problematical, and the hope of a suitable reward in recompence of his toil either in the form of approbation, if deserved, or money, should the undertaking be of a sufficiently popular character to lead to so substantial a termination.

There is also another reason which renders the writing of the preface an agreeable occupation. It is the opportunity which it affords to the writer to render to those who have aided him in his enquiries the acknowledgments which their liberality and their kindness so strongly claim.

To Sir W. J. Hooker, Dr. Greville, Mr. Borrer, Dr. Harvey, and the Rev. M. J. Berkeley, names prominently inscribed in the records of the successful cultivators of natural science, the pursuit of which is the most peaceful and the most pleasant of all employments, I am deeply indebted. The two former gentlemen liberally placed at my disposal their valuable collections of freshwater *Algæ*, and Mr. Harvey and Mr. Berkeley communicated to me numerous unique specimens accompanied by valuable remarks.

To Mr. Jenner, one of the most untiring and successful of Cryptogamic botanists, and whose excellent Flora of Tunbridge Wells is I believe the only one which contains any thing like a complete list of the freshwater *Algæ*, I am likewise greatly indebted for numberless recent specimens of *Algæ*, which otherwise I had never seen, as well as for many original and accurate remarks.

To Dr. G. J. Allman, my highly valued friend, and the talented Professor of Botany in the Dublin University; to Dr. Johnston, of whose valuable instructions in zoophytology I entertain a grateful remembrance, and to be the pupil of such a master any man might be proud; to MM. Montaigne, Areschoug, Decaisne, and Mr. Shuttleworth, whose residence in foreign lands precluded unfortunately frequent communication, and from whom therefore I regret that I have not been able to obtain more of that information of which they are so largely possessed; to Mr. Thwaites, of Bristol, Mr. Sidebotham, of Manchester, Dr. Dickie, of Aberdeen, Mr. M'Calla, of Ireland, and Mr. Thompson, of Belfast, my warmest thanks are due.

I must not forget also to acknowledge the literary assistance which I have derived from Mr. Coppin, of Trinity College, Cambridge, nor omit to mention the deep obligation I am under to a lady for the devotion of much time to the shading of many of the plates.

To Mr. Ross, the eminent optician, with one of whose instruments most of the nicer observations were made, my acknowledgments are likewise due.

To the Subscribers also to this work I feel much indebted; their generous patronage has relieved my mind of considerable anxiety, for it has removed all pecuniary risk to myself, if it has not insured a reward of the same nature.

Norland Villa, Addison Road North, Notting Hill,
July, 1845.

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INTRODUCTION.

At the period when the researches hereafter to be detailed were undertaken with a view to publication, viz., in the spring of the year 1840, no department of Cryptogamic Botany was in so unsatisfactory and obscure a state as that of the freshwater *Algæ;* the works and memoirs, comparatively few in number, which had then appeared, either in this country or on the Continent, abounding with descriptions incomplete, inaccurate, or repetitions of the same productions and facts under different forms and appearances.

That such should have been the case is not so surprising, when the minuteness of the objects composing the majority of this fertile class of Nature's exhaustless works is considered (the individual parts of many of them being more slender than the human hair), and when, also, the imperfection of the microscopic instruments until recently employed in their investigation, and their changing and fragile character, are taken into account, these circumstances rendering a patient and long-continued study of them necessary. It nevertheless must be regarded as somewhat remarkable, that a field so rich in discovery and of such high interest, until very lately, should have been so little explored; and that such would have been the case, was certainly not in accordance with the expectations of Vaucher when he penned the following remarks in the introduction to his eloquent and admirable

"Histoire des Conferves d'Eau Douce,"—admirable, when the epoch at which it was undertaken, and the means at his disposal, are considered. "I wish," he says, at p. 8., "that those who love Botany may see what are our riches in this respect, and what are the discoveries reserved to their perseverance: now that the way is open, more persons should engage themselves in the study of these objects, and they should be more rapidly studied. If this work excites the attention of the public, there should appear on all sides observations on new *Confervæ* and there will be announced, perhaps, productions more singular than those which I describe. This taste for research will not be confined to this one genus, but it will extend to other neighbouring genera, which equally require to be studied; and this beautiful part of Botany will be insensibly drawn from the confusion in which it has for so long a time been found."

An additional reason why the knowledge of the freshwater *Algæ*, and particularly the Confervoid division of that tribe, should for so long a time have remained in such a confused and imperfect state, consisted in the want of a due appreciation of the value of the characters founded on their reproduction, these being of more importance, in the establishment of the different families, genera and species, than all the other signs and characters derived from attention to other conditions and appearances of these plants. To a right appreciation of the importance of attention to the reproduction of the *Confervæ* it is that the superiority of Vaucher's "Histoire des Conferves d'Eau Douce," is mainly owing, over other works on the same subject, that close and amiable observer having made—and he was the first, and almost the only one to do so—a knowledge of their reproduction his chief aim and study. Thus the majority of the earlier observers, and some even of recent date, have deemed it sufficient to describe any plant of this class merely from the appearance which it presented on a first examination, without any reference to the stage of developement or condition of that plant; and have of course expected that the productions thus imperfectly recorded should have been recognized with facility by subsequent in-

vestigators, and handed down to posterity. Such expectations, however, it is impossible to realise; and I agree with Vaucher in thinking, that the wisest course to adopt would be (except in some few cases, where the productions can with certainty be determined by other characters,) to notice only those species whose reproduction has been satisfactorily made out.

In the present work, the necessity for which is in a measure indicated by the preceding remarks, the characters developed in the state of reproduction are relied upon, in the framing not merely of the families and genera, but also in the definition of species, for which they are even more valuable.

In this Introduction it is not intended that a *full* description should be given of the different modes of reproduction and of the structure of the freshwater *Algæ*, the *details* of these coming under consideration with more propriety when the divisions into families, genera, and species are treated of. The general particulars of each will, however, be now noticed.

Linnæus supposed that all vegetable productions owed their perpetuity to sexes: he did not, however, assign in his system any fructification to the *Confervæ*. Had Linnæus, nevertheless, been aware of the highly curious and interesting facts which more recent investigation has made known, viz., of the phenomenon of the union of two cells, either in different or in the same filaments, which so frequently occurs amongst the *Confervæ* (see Plates 30—50. and 33.), he would doubtless have regarded this commingling as not merely strengthening, but proving the correctness of his views of the sexual character of all plants. But it is to be questioned how far the fact just alluded to would bear any such interpretation, its tendency in support of the opinions of the illustrious Swede being completely neutralised by our acquaintance with other facts, and chiefly with this, viz., that in a considerable proportion of freshwater species, and probably in the entire of the marine *Confervæ*, no such conjunction of filaments or commingling of the contents of two cells occurs, all the requisites for the continuance of these being indisputably contained within each cell, no exterior organs of reproduction ever having been discovered in the vast majority of these. The

exact similarity of the contents of the different cells,—no difference being detected, even with the assistance of the most powerful glasses,—and the principal mode of growth of the *Confervæ*, by the extension and repeated sub-division of the primary cell,—would tend to lead likewise to a similar conclusion.

Notwithstanding the difficulties which lie in the way of regarding each cell of a *Conferva* as the representative of a sex, the frequency with which the phenomenon of union of the filaments, and commixture of the contents of two cells, takes place, cannot be regarded otherwise than as most curious, though the purpose to which it is subservient is so obscure. It may be, that it merely serves to bring a number of the reproductive granules into contact, and which, becoming subsequently clothed with a membrane, are thus the better preserved until the proper time for their germination arrives.

Another circumstance opposed to the sexual view as regards distinct cells, is that, in those genera even in which either the cells or their contents unite, exceptions occur in which there is an absence of conjugation of the filaments, and commingling of endochrome or vesicular contents of the cells; and in other cases there is conjugation, but no mixture of the endochrome of the united cells.

Thus, so far as can be presumed, the information already acquired would appear to be opposed to the belief in the existence of sexes as applied to cells in the *Confervæ*. A fertilization of the sporules does doubtless occur; and this I believe to be effected through the agency of the following structure, described, nearly as below, in the "Annals of Natural History," vol. xii. p. 20. In this description it will be seen that a double office has been attributed to it; I am now induced to limit its use to the one, the important one, of fertilization.

From the high developement of the cells of many *Algæ*, both marine and freshwater, as well as from their extreme transparency, in many species, it might have been supposed that the first discovery of those curious organs, termed cytoblasts, which exercise an influence so mysterious on the de-

velopement of cells, and whose presence in cellular structure is so constant as to lead to the suspicion that the association of the two organisms is universal, would have been made in this extensive tribe of Nature's wondrous works; so far, however from this being the case, they have not as yet, so far as I can learn, been noticed in any species of *Alga;* a description of them, therefore, as they occur in two genera of freshwater *Confervæ, Zygnema* and *Vesiculifera,* cannot fail to be of interest.

In the first of these genera, *Zygnema,* their structure is exceedingly complicated.* Each cytoblast is solitary, and usually occupies a central situation in each cell of a *Zygnema.* It consists generally of two membranes, but sometimes there are three; the innermost of these being either circular or elliptical, (the form varying with the species itself, as well as its condition,) and presenting a nucleated appearance; and all are separated from each other by distinct intervals, which are filled with fluid. The surface of the enclosed membrane or membranes is smooth; while that of the external is rendered irregular by the giving off of numerous tubular prolongations or radii, which terminate in the spiral threads formed by mucus, endochrome, and large bright granules, which I regard as the unfertilized zoospores.

Wishing to have a corroboration of my views respecting the structure of the cytoblastic organ described above, and also to learn as much respecting its anatomy as possible, I forwarded a specimen of *Zygnema nitidum* to that able and most obliging observer, J. S. Bowerbank, Esq., whose opinion of its structure exactly coincides with my own, that gentleman having in particular satisfied himself of the tubular nature of the prolongations sent off by the external membrane, and of their termination in the spiral threads.

The structure of this curious organ explains with apparent satisfaction one of the offices which it is destined to discharge, viz., that of a laboratory or *stomach,* in which the materials necessary for the growth and vitality of the cell and its contents are received and digested, and from which they are

* See Plate 17. *fig.* 1, 2 3.

conveyed, by means of the tubular radii, to those organs by which the materials are to be assimilated.

The cytoblast, therefore, is at first fixed in the centre of the cell by the prolongations which proceed from it: but it happens, that at a certain epoch these radii disappear, and then the cytoblast floats freely within the cavity of the cell; the disappearance of the rays, the cessation of the growth of the cells, and the assumption of the characters of reproduction being almost contemporaneous, or, at any rate, events immediately consecutive on each other, and the two latter being readily accounted for by the disappearance of the radii.

The circumstance of the increased developement of the cytoblastic body subsequent to the removal of the radii, gives weight, to the opinion that this organ has yet another office to perform, in addition to that of presiding over the growth of the cells; for were it not so, it might be expected that on the disappearance of the rays it would shrivel up, and at length become absorbed, as is the case with other organs, their allotted duties having been performed: and the office which I would attribute to it, is one even of more importance than that previously remarked upon, it being no other than the fertilization of the brilliant granules entering into the formation of the spiral threads, and which I regard, as before noticed, as the unfertilized zoospores.

The adoption of the view which supposes the fertilization of the reproductive bodies by means of the organ whose complicated anatomy has been dwelt upon, would have the effect of removing some grand difficulties in the way of the complete understanding of these most interesting productions. Thus, first, by furnishing a definite organ whereby fertilization is occasioned, it removes the inability which has hitherto been felt to explain in what way the intermingling of bodies, in all respects so similar in organization and appearance as the bright granules of the *Conferv*æ seem to be, can be regarded as giving origin to fertility: secondly, it does away with the anomaly, which has always appeared to me so strange, that a combination of the matter of two cells should invariably take place in certain divisions of the Confervoid tribe of

productions; while in other divisions of the same tribe, which could not be supposed to differ fundamentally from the former, no such phenomenon has hitherto been recognized; by shewing that this combination is not an essential to the perpetuation of the species: and thirdly, it explains the permanence of species which have perished before union of the endochrome and formation of spores have taken place.

I have detected cytoblasts in numerous *Zygniemata*, but the best species in which to examine them are the larger kinds, such as *Zygnema maximum*, *Z. nitidum*, and *Z. belle*. Of the genus *Vesiculifera*, I have also found it in several species: they cannot always be seen in these, owing to the cells not being so transparent. I doubt not, however, but that they are general in it, as well as other genera of *Algæ*, whether marine or freshwater. In this genus it is but a simple vesicle; at least, I have never observed it in any other state. (See Plate 17. *fig.* 6.)

The Rev. M. J. Berkeley has kindly favoured me with an abstract of a paper by Hugo Mohl on the genus *Anthoceros*, published in 1839, and inserted in "Linnæa," vol. xiii. p. 273., in the cells of which an organ occurs bearing a considerable external resemblance to the radiated structure met with in the cells of *Zygnema*.

The following is a brief outline of the mode of formation of this structure in the genus *Anthoceros*. When an immature cell of one of the species of this genus is examined, a portion of its interior is seen to be occupied by a layer of green granules, through which may be seen a cytoblast, the other portion of the cell being colourless. Treated with iodine, the layer formed by green granules, as also the colourless part of the cell, becomes yellow, showing that the whole is really lined with a sort of quasi membrane. Gradually the green layer becomes concentrated into two masses, which commence to advance more and more towards the middle of the cells, and the edges of these masses spreading in various degrees over the inner wall of the cell, leave intervals of various sizes, which give to them a cellular appearance. "The nucleus, or cytoblast," Mohl observes, "has no part in

this formation. Frequently it is so concealed beneath the green granular mass, that it cannot be seen without some trouble: sometimes it lies near to or between both divisions of the green mass, and then more easily comes into sight; but at the same time it is observable, that it remains unaltered, and is foreign to the whole of the slimy structure described above. The latter seems only so far to have a relation to it, that its point of concentration is always at the place where the nucleus lies, and indeed between it and the walls of the mother cell."

Subsequently, the two masses become divided into four, and the reticulated appearance produced by the spreading of the masses subsides into radii, which are similar in aspect to those emanating from the cytoblast in the *Zygnemata*, each arising separately from the masses, and terminating on the inner surface of the cell. Finally, each radiated mass becomes a perfect spore or cell, separated from each other by distinct cellular walls, in which changes similar to those just described take place for the production of other spores. The great similarity in the structure of the incipient spores in the genus *Anthoceros* with that of the radiated organs in *Zygnema*, would lead to the supposition that they were identical in their nature; so far, however, from this being the case, I consider that all analogy between them terminates with the outward resemblance. The difficulties in the way of regarding the structure in *Zygnema* as an incipient germ or spore, appear to me to be insuperable; for the question would immediately arise, wherefore is it, that since the contents of *two* cells generally go to form a single spore in the genus *Zygnema*, and since this radiated organ is present in *every* cell, that the one is suppressed, while the other is destined to give birth to the future *Zygnema?* Supposing, however, a satisfactory solution of this difficulty to have been made, still another arises. It is far from being an incontrovertibly established fact, that the elliptical body formed in *Zygnema* by the concentration of the matter of two cells, and usually denominated a spore, does really contain but a single germ. It is far more consistent with known facts to suppose that they are

sporangia filled with fertilized sporules; for this is certain, that numerous zoospores are formed within each cell, and which may even be seen through the membrane of the sporangia themselves by the aid of a good glass, these zoospores being also identical with the brilliant granules of the *Algæ*.

The highly interesting observations of Mohl on the genus *Anthoceros*, the accuracy of which is in no respect questioned by me, do not therefore occasion any modification of the views expressed of the functions of the radiated organ in *Zygnema*.

In October, 1843, I learned that Kutzing, in his "Phycologia Generalis," published in August of the same year, had noticed and figured the cytoblastic organ just described; and that Meyen had also previously observed it; where, however, this is recorded, I cannot ascertain. Kutzing thus speaks of it: "Meyen has discovered in the *Spirogyræ* a a peculiar central organ. In *Sp. nitida* it occurs in the middle of each cell, but is here only to be easily seen in such cells as are larger than ordinary; and, from that cause, present more lax spiral bands. By employing the tincture of iodine, one observes these bodies more easily. Each organ becomes, together with the delicate threads to which it is appended, coloured brown by it. It consists of a (Schwal-gedrücken) slightly compressed gonidium, through which may be seen a peculiar nucleus in the midst, and a number of very fine filaments, which extend from it, in a stellate manner, on all sides, and are fastened internally to the spiral bands. At the place where they are attached to these last, their points become somewhat expanded. By means of these stellate filaments the central body becomes suspended in the centre of the cell. M. Schleiden calls these bodies cytoblasts, and is of opinion that the so-called nucleus threads, to which they are attached, are nothing else than very delicate streams of sap, which proceed from the cytoblast, and return to it. Without wishing to throw doubt upon this pretended flow of sap, I must, nevertheless, own that I have not been able to observe it with a microscope of Schiek's or Phoflschen's manufacture; but I have observed that the rays of Meyen's

central organ are really sometimes more than mere streams; at least, that they are mucous threads, since they become tinged brown with the tincture of iodine, and do not in the least alter either their form or position. Schleiden has also, at the same time, observed reticulate, anastamosing little streams upon the central wall of the cell, but especially at the free ends where the green spiral bands cease, and the cells consequently become lighter and more transparent. This appearance, also, has not yet presented itself to me. I have, however, more than ten years ago, seen in the *Zygnemata*, motions of very little granules, which resemble those which I have already pointed out in *Oedogonium vesicatum* and *O. capillare*. They extend sometimes throughout the entire inner space of the cell, and are especially evident in freshly broken-off terminal cells. That the cytoblast really occasions this motion, I doubt, because it occurs in all the other cells of the *Alga* which do not possess the central organs."

Having thus described what I conceive to be the organ whereby the reproductive germs are fertilized, we come now to consider these bodies themselves, which, according to some observers, are twofold—zoospores and spores. We shall speak first of the former. When a portion of a *Conferva*, for example a *Vesiculifera*, in an early condition of its growth is placed beneath the microscope, in each cell are observed numerous spherical granules, each having a dark central nucleus, and the size and amount of these varying extremely; and all being, at this period, connected with each other by a tubular or vascular network.* As the spocies approaches to a state of maturity, these bodies will be seen to have undergone a considerable increase of size and change of form, they now being no longer spherical, but pyriform, the inflated portions being filled with endochrome, in the midst of which one or two incipient germs can, even at this early period, be observed, and the apices, or, as they have been

* For an account of this, see paper by me in "Annals and Magazine of Natural History," vol. xii. p. 25.

termed, the rostra, being transparent; near which also is sometimes observed a pinkish spot similar to that which is seen in the infusory animalcules. The vascular network has now disappeared, and the zoospores lie detached in the cell. At length the granules become perfected, and they are now seen moving restlessly about the interior of the cell, frequently striking against its walls, as though anxious to escape from the confinement of their narrow cell, and to rove about, independent beings, through the waters, in search of an appropriate abiding-place. Having escaped from the cells, which they are enabled to do, not as Agardh supposed, by the multiplied knockings of their beaks against its sides, whereby its fibres become displaced, but either by rupturing its walls, through their increased developement, as in *Lyngbya*, &c., or by some special provision, as in *Vesiculifera*, *Zygnema*, &c., they fall into the water, through which they speedily begin to move hither and thither; now progressing in a straight line, with the rostra in advance; now wheeling round and pursuing a different course; now letting their rostra drop, and oscillating upon them, like (to compare small things with great) balloons ere the strings are cut, or like tops, the centripetal force being nearly expended; now altogether stopping, and anon resuming their curious and eccentric motions. Truly wonderful is the velocity with which these microscopic objects progress, their relative speed far surpassing that of the fleetest race-horse. After a time, however, which frequently extends to some two or three hours, the motion becomes much retarded, and at length, after faint struggles, entirely ceases, and the zoospores then lie as though dead: not so, nevertheless; they have merely lost the power of locomotion; the vital principle is still active within them, and they are seen to expand, to become partitioned, and, if the species be of an attached kind, each zoospore will emit from its transparent extremity two or more radicles, whereby it becomes finally and for ever fixed. Strange transition, from the roving life of the animal to the fixed existence of the plant! In exact correspondence with this, is what occurs with the Zoophytes.

So extraordinary were the statements from time to time put forth relative to the spontaneous motion of the reproductive germs of many *Algæ* — a class of productions always regarded as vegetable — considered to be, that many observers, and some do even now, refuse to give their belief to their accuracy. So numerous are the observers who have witnessed the singular motions above recorded, that the facts announced in reference to them must be regarded as amongst those which ought to be generally received and adopted. For a long time I myself doubted the reality of the existence of zoospores; I have now satisfied myself on this head, having repeatedly witnessed their movements in very many *Confervæ*, but never as yet in any species belonging to the conjugative tribe of *Algæ;* in which, however, Agardh declares himself to have witnessed it. For extended observations on the motion of the zoospores of the *Algæ*, see, in "Annales des Sciences Naturelles (Botanique), 1836," a memoir "Sur la Propagation des Algues. Par J. G. Agardh. Extrait."

It is surprising that, out of the number of those who now study the *Algæ*, so few should have witnessed the singular motion of the zoospores. The spring is the best season for observing these bodies. If, at that time, a number of *Algæ*, collected indiscriminately from different localities, are placed in a vessel of water over-night, and allowed to remain undisturbed until the morning, usually there will be noticed on the surface of the water a thin green pellicle or scum: this, when examined, will be found to consist of the zoospores of different species of *Confervæ*, in all possible stages of developement. Their motion is most active early in the morning; and they would appear to shun the light, as they are generally met with on the side of the vessel farthest removed therefrom.

Next in interest to the discovery of the zoospores themselves, and for which science was mainly indebted to the researches of J. G. Agardh, is that of the means by which their motion is effected. J. G. Agardh declared that it depended upon the movement of a prolongation or beak, with which each zoospore was said to be furnished; others

have endeavoured to account for it by reference to the principle of endosmosis; but neither of these explanations can be deemed satisfactory; the true cause of it depending, according to the researches of M. Unger*, and M. Gustave Thuret†, upon the presence of cilia, similar to those of the infusory animalcules. The following abstract of M. Thuret's paper, on a subject of such high interest, cannot fail of being acceptable.

The spontaneous movement of the spores of the Algæ has been viewed by a great many observers. In certain cases it is apparent to the unaided sight; but until now, as declares M. Dujardin, in his "Observateur, ou Microscope" (Paris, 1843), they have not been able to discover by what means the spores swim in the liquid. Nevertheless, the cilia, or filiform tentacles, which serve them as locomotive organs, do not appear to me more difficult to see than the filaments discovered by M. Dujardin in a great number of Infusoria; and if they have escaped an observer so practised, it is, without doubt, because he has not continued his researches with enough of perseverance, or else, that he has not made them in all the conditions necessary for success.

In fine, the movement of the spores continues for some hours, during which the locomotive organs are in incessant agitation, and in consequence very difficult to distinguish. The use of coloured infusions cannot but detect their existence. When the spore stops, the locomotive organs disappear very quickly, without leaving any traces, and some time after, the germination commences. It is necessary then to seize the precise instant when the spores cease to move; or, to make the chances of success greater, it is necessary, when one finds those which move with vivacity, to put them in contact with a reagent the action of which is too feeble to alter their form, but enough to stop their movements. Opium and iodine appear to me the agents the most proper to obtain this result.

* Die Pflanze in Momente der Thierwerdung. Wien. 1843.

† Researches sur les Organes Locomoteurs des Spores des Algues. Par M. Gustave Thuret. Ann. des Sciences Nat., Mai et Juin, 1843.

The organization the most simple, is that which is found in the *Confervæ;* and I have reason to think that it represents a type general to the spores of the *Algæ.* I have studied it in the *Conferva glomerata* and *C. rivularis;* the spores are altogether alike in both species, and I have seen in the one all that I have observed in the other. Their form is turbinated; the thin extremity, deprived of endochrome, to which the name of rostrum or beak has been given, bears two cilia or filiform tentacles, the length of which surpasses that of the spores; they are the locomotive organs. (See Plate I. *fig.* 1, 2.) The spore moves ordinarily with the beak in advance, and turns about in the water with a movement of trepidation, which recalls to mind that which I have observed in the animalcules of the anther of *Chara:* this analogy applies itself more closely from the resemblance of the organs of locomotion. From time to time the spore suddenly stops; and often, likewise, it twirls round upon its great axis. The light exerts a marked influence upon the direction of its march. A small quantity of the watery extract of opium is sufficient to arrest their movements. The tentacles are then easily distinguished by a linear power of 240 times (la vue moyenne étant comptée à 25 centimetres). They are rendered still more visible by employing the alcoholic tincture of iodine, more or less weak. If afterwards the spores are left to dry between two plates of glass, the tentacles will not be observed to be altered by the drying, but they come in a manner more satisfactory and positive upon the bottom of the microscope, because they are placed in a medium less refracting. It is necessary to remark, moreover, (and this observation applies to all spores of the *Algæ* which are prepared in this manner,) that, the spore contracting itself by drying, the tentacles appear a little longer.

It is in the morning more particularly that the greatest number of spores of *Confervæ* are found in action. Those which one observes after mid-day are for the most part stopped, or have already commenced to germinate. The motionless spores all present, towards the beak, a point coloured

red, which adds still further to their resemblance to certain Infusoria, especially to some *Thecamonadiens.*

The *Chætophora elegans* (var. *pisiformis*) presents to us a more complicated organization. The beak bears four locomotive tentacles, instead of two.. These spores are very small also, and difficult to observe. (See Plate I. *fig.* 10.)

In the *Proliferæ* (*Conferva vesicata, tumidula,* and *alternata*), the organization is still more complicated; and this difference of the spores is an additional motive for separating these plants from the real *Confervæ.* Two species of this kind have served me in my researches: the first seems to be referrible to *Prolifera rivularis* of M. Leon Le Clerc*; and the other, a great deal smaller in all its parts, to *Prolifera Candollii* of the same author. Both have the spores, the beak is rounded, and bears a crown of filiform tentacles (see Plate I. *fig.* 13. 18.), which opium or iodine renders motionless. Their movements are very nearly the same as those of the spores of the *Confervæ,* but much more rapid, by reason of the greater powers of their locomotive organs. When these spores are disposed to germinate, they fix themselves by the beak to all tendrils which float in the water, and throw out prolongations or root-like claws, which render them very adherent. The filaments of *Prolifera,* or *Conferva,* are often rendered rough with this kind of parasitic vegetation. This fact, ill understood, caused the creation, by Vaucher, of the erroneous appellation of *Prolifera.* If the plant is removed from the water at the moment of the emission of the spores, they fix themselves around the crystals produced by the evaporation of the liquid; and when the germination commences, one may see every little crystal charged with a multitude of spores which radiate in all directions.

The *Vaucheria,* estranged from the genera of which we have been speaking, by its structure, and by the mode of the formation of its spores, is distinguished equally by the disposition of its locomotive organs. The spore is an ovoid

* Sur la Fructification du Genre Prolifère. (Mémoires du Muséum, tom. iii. p. 462. pl. 23.)

vesicle which attains the thirtieth of a millemetre in length. It is entirely invested with cilia, rather short, the vibration of which determines the advancing movement of the spore. M. Unger first pointed out these organs in a great and curious work recently published.* The interest of the subject, and the facility of procuring each day fresh specimens, from January until May, determined me to study that plant with care. I proceed to give the result of my observations.

The tufts of the *Vaucheria* (*V. clavata*) are formed of a network of filaments, cylindrical, branched, continuous, which enclose the green granules (endochrome) and colourless mucilage. At the period of the formation of the spore, the extremity of its filaments swell up in the form of a club, and the green matter becomes there condensed, so as to assume a blackish tint. (See Plate II. *fig.* 21, 22.) Near the base of the enlargement the granules are seen separated the one from the other, leaving an empty space as if the mucilage had condensed itself in its turn, and driven the granules above and below. This displacement continues until the endochrome forms well-defined lines on each side. (See Plate II. *fig.* 23.) Then the great change takes place, which consists in the operation which we are about to describe, viz. the separation of the mother plant and of the reproductive body, subsequently clothed with a membrane proper to itself (epispore), possessing a distinct organization.

Although this phenomenon continues but for a few minutes, it is easy to observe it, since the movement of the granules is almost insensible. Moreover, the separation is not discontinued after the first time. I have seen the operation thrice repeated upon the same filament.

The spore then takes the form of *fig.* 24.; that of an elongated oval vesicle, whose two divisions are nearly black by the condensation of the endochrome, the inferior division containing much less endochrome. It is then that the crisis approaches: the superior extremity suddenly becomes protruded, the granular fluid empties itself into the protruded

* Die Pflanze in Momente der Thierwerdung. Wien. 1843.

portion which quickly increases in volume, so that the opposite extremity becomes separated from the filament. At the same time the spore commences to turn on its great axis in such a manner, as that all the granules which it contains are seen to pass rapidly from right to left, and from left to right, as though they moved in the interior of a transparent cylinder. The operation by which the spore endeavours to escape occasions a very marked contraction; but in some few instances it succeeds in disengaging itself, and springs with rapidity into the surrounding liquid. The colourless part, which corresponds to the beak, is always directed in advance. The spore does not cease to turn upon itself, but its progress is somewhat regular, quicker or slower in one direction or another; in general, it quickly reaches the edge of the glass as though it tried to escape; sometimes it stops; then in an instant afterwards it resumes its course. The epispore from which the cilia proceed describes a large granular areola. As to the cilia themselves, they are invisible by reason of the rapidity of their movement; but we may judge well of their action by putting the spore in an infusion of carmine, indigo, or gum water, &c. Nothing is more curious than to follow its progress in a strong infusion of carmine for example. The coloured granules through which the spore makes its way are driven with force by the motion of the cilia; a rapid current is established on each side of the spore, and a long track is described after it. When it meets with an obstacle, such as the filaments of *Zygnema* or *Vaucheria*, it becomes deformed (or is put out of proportion); but the motion of the cilia is not arrested. It is also the same when it is compressed even to the extent of producing the extravasation of the endochrome; the vibration of the cilia continues in the part not injured. I have observed many times the emission of the spore in a coloured infusion, and then noticed that the agitation of the granules by the motion of the cilia is not felt until about a fourth part of the spore has been released.

It is necessary, in order the better to see the cilia, to arrest them by means of some reagent, such as opium, iodine, the proto-nitrate of mercury, &c. The effects of the watery

extract of opium are very remarkable: the motion is retarded gradually, so that the play of these organs can be well distinguished. The iodine water, although it contains but an extremely small quantity of iodine ($\frac{1}{7000}$), arrests suddenly the cilia, which become plainly visible. The alcoholic tincture of iodine may also be employed, but very weak. If afterwards the spore is dried between two plates of glass, the cilia will be sufficiently distinct to be seen by the simple microscope.

M. Unger has followed the movements of a liberated spore in water during more than two hours. The greatest length of time during which I have observed it with the microscope has been nineteen minutes, and, in general, the motion continues but little more than half of this time: sometimes it ceases almost immediately after the release. But it is necessary to remark, that the spore, being placed upon the object glass, was imprisoned between two plates of glass. The vibration of the cilia continues sometimes after the spore is arrested; only it is not sufficiently strong to displace the corpuscle. When at last they cease to move, the contour of the spore undergoes during some instants a sensible alteration, which announces, perhaps, the decomposition or the absorption of the vibratile organs. The motionless spore delays not to modify itself once again: it becomes spherical, the green matter distributes itself equally, and the episporic membrane, in part reabsorbed, at last escapes the sight; very soon germination commences.

M. Unger remarks that the escape of almost all the spores takes place towards eight in the morning. Indeed, all the work of the formation of the spore is carried on in the first hours of the day. The tufts which I have gathered the day before, and which presented no indication of the formation being near at hand, were in general covered with spores the next morning; and after mid-day these were all gathered on the surface of the water beginning to germinate.

It is easy to follow the progress of this germination under the microscope: the elongation of the filaments progresses, one might say, by eyesight; for I have measured more than

once an increase of three-twentieths of a millemetre in an hour. Moreover, the activity of this phenomenon, as of all those which I shall hereafter describe, varies extremely, according to the state of the tufts of *Vaucheria* which have been gathered. It is the same with the diameter of the spores, and the size of the filaments, &c., upon which one is not able to give a certain determination. Therefore, in the figures which I append to this note, all the modifications which the spores of *Vaucheria* may present, either before or after their emission, ought not to be expected to be found; but I have chosen in my drawings those which have appeared to me to represent their most usual and characteristic state.

The power of germination is moreover carried in *Vaucheria* to a point which appears to me to surpass all that is observed in the vegetable kingdom. This plant, which consists, to speak truly, but of a single cell, possesses in all its parts the faculty of reproducing itself. The extremities of the filaments kept for many weeks, evaporation being prevented, continue to elongate until they have extended themselves beyond the plate of glass which serves to sustain them. Again, when one of these filaments has undergone lesions in many places, the green matter is seen to become secreted gradually between one end of the injured places and the filament, and to divide itself thus into many little fragments, which form so many distinct individuals emitting lateral prolongations, and not tarrying, without doubt, under favourable circumstances, to reproduce a complete individual.

The phenomenon of the deliverance of the spore is not always accomplished so regularly as I have described; sometimes it germinates without quitting the mother plant; and from this result the strange forms which I have represented in figures 35 and 36. Sometimes also the spore cuts itself into two at the moment of its escape, and so gives birth to two spores, smaller than the others, but capable of germination like them, the one at the exterior, the other at the interior, of the filament.

The transparent membrane which enclosed the spore, and which became visible after its emission, is destroyed little

by little. It is perfectly homogeneous; it is but when it commences to decompose that it takes on a granular appearance; but it never presents those longitudinal striæ which I have remarked in that of *Conferva* and *Zygnema*.

I have not perceived any motion in the granules of the endochrome, excepting in the case of the rupture of a filament. The granules escape then in jerks; they often collect themselves into pellets, and sometimes the mucilage which accompanies them forms about them a species of membrane; but these masses of granules have never appeared to me susceptible of organization into reproductive corpuscles; in a word, never have I seen them germinate.

The solubility of these granules in alcohol indicates their resinous nature. Sulphuric acid diluted with water contracts them into the centre of the filament to a faint ribbon of a brownish green. When this reagent is employed of greater strength, the granules resolve themselves into a mass of a blackish green; but the external membrane resists the action of the acid. If recourse is had to ammonia, it often happens that, by a phenomenon of endosmosis, the filaments empty themselves entirely of their granules. This is seen especially in the spores which have commenced to germinate; the granules all issue by the extremity of the filament in germination, and the external membrane, which was not before visible but at the extremity of this filament, remains entirely empty like to a glass ball. The ammonia possesses also the singular property of imparting a light pink coloration, or vinous red, to certain parts of *Vaucheria*, particularly to the superior extremity of the spore, when it is at the instant of quitting the mother plant, and this part is less furnished with endochrome than the rest.

If I have not indicated up to the present time to what species of *Vaucheria* the observations which I have described apply, it is because the species of this genus are established upon bad characters. In truth, the organization of the spore, such as I have described it, applies to *Vaucheria ovata* D. C. = *Vaucheria clavata* D. C. et Unger; for I have found once, upon the same filament, both this form and that which has been named *Vaucheria sessilis*. A

little time afterwards, the same tufts again have given me *Vaucheria hamata, V. geminata,* &c. The appendages that Vaucher regarded as the corpuscles, and which served him to establish his species, are very different from true spores by the thickness of their envelope, and by the nature of their contents. Crushed under the microscope, they permit drops of a very refracting liquid to escape, which alcohol dissolves not, but of which it renders the green colour more brilliant. Sulphuric acid causes it to change to a clear fawn, and iodine to brown. It is true that these appendages are formed, like the spores, by the condensation of the green matter, and that they are separated from the mother plant by a diaphragm; but I have never found them but upon filaments which have begun to disorganize themselves, and almost always they decompose with them. Now, since I have constantly gathered in the same locality all the individuals of *Vaucheria* which have served for my observations, and since I have seen them take successively all the forms represented in the annexed plates, I believe that I ought to unite *Vaucheria ovata, clavata, sessilis, hamata, terrestris, geminata, cæspitosa, cruciata,* into a single species, which I propose to designate under the name of *Vaucheria Ungeri,* in remembrance of the learned work of the German author and his interesting discovery.

We have examined four different types of locomotive organs in the spores of the *Algæ:* analogous organs are to be found, without doubt, in a host of plants of this class; and it is allowable for us to suppose that the different groups present different forms. I should have been able myself to add yet many genera to those which I have mentioned, but I believe that it would be sufficient in this first work to indicate the principal types which observation has, up to the present time, made me acquainted with, and to cite for each of them a genus in which this type is found. I would add in conclusion, in order to give more authority to my assertions, that M. Decaisne has verified the most part of my results; and that I owe him even certain of the figures which accompany this note. (Ann. des Sciences Nat. 1843.)

That M. G. Thuret is in error in uniting all the species of *Vaucheria* into one, will, by a reference to the descriptions and figures of the genus *Vaucheria*, which accompany this work, be at once perceived.

The animalcules contained in the cells of the filaments, which occupy the interior of the globule of *Chara*, bear considerable resemblance to the zoospores of the *Algæ*; like them, owing their power of locomotion to the presence of cilia, the anterior extremity of each being furnished with two long lashes or cilia (see plate 62., *fig.* 5, 6.). If the views of physiologists, however, respecting them be correct, an essential and functional distinction exists between them; the one being the sporules themselves, and the other the organism, or instruments, whereby those sporules are fertilized.

While the term zoospore has been applied to the moving sporules of the *Algæ*, the appellation of spore has been conferred by some writers upon the large and usually elliptical body formed in the different species of the genera *Zygnema**, *Tyndaridea*, *Staurocarpus*, *Mesocarpus*, *Mougeotia*, *Vesiculifera*, and perhaps *Bulbochæte*, by the union and consolidation of the contents of two cells either in the same or different filaments. Concerning the nature of this body, considerable difference of opinion has prevailed and still obtains. Vaucher, who has so accurately described numerous species of *Conjugatæ*, thus speaks of it:—"At last, on the 25th Messidor, an IX, in examining the remains of the *Conferva jugalis* Muller, which I had followed since the commencement of spring, I arrived fully and without any doubt at this truth so desired, and which I had made so long and so fruitlessly the object of my researches. Almost at the same instant, and in the same day, or at least in the same week, all the grains of the *Conferva jugalis*, of which I had many thousands, opened themselves by one of their extremities, in the same manner as the two cotyledons of a seed whose embryo has become developed; and from the

* See the figures of those genera.

base of the aperture there issued a green sac, at first very small, but which soon extended itself in such a manner that it surpassed many times the length of the globule. In the interior of this sac appear soon the spires, they being accompanied by their brilliant points, as in a *Conjugata* entirely developed. The tube itself exhibits divisions, at first one, afterwards two, then a great number; at last the *Conjugata* detaches itself from its grain, and floats alone in the liquid, and then nearly in size, and with two extremities, which are still pointed, it resembles perfectly the plant which gave it birth." In this description Vaucher is doubtless altogether in error; and it is difficult to conceive in what way he could have been so imposed upon, a careful microscopic examination of the "spore" alone being quite sufficient to convince the observer that no such dehiscence as that represented by Vaucher could take place. M. Decaisne * regards these bodies as the true and only germs of the *Conjugatæ* or Sunspores, as he has denominated them in removing them from Agardh's extensive class of Zoospores. Mr. Jenner, an indefatigable and excellent observer, writes me word that he has witnessed the growth of these "spores," "which is, by a general extension of the whole investing membrane or membranes, which subsequently divides and subdivides into other cells;" and Kützing also, if I mistake not, states that he has been a witness of their developement in *Zygnema* and *Vesiculifera*, or *Œdogonium*. Agardh thus writes in the memoir before alluded to concerning them in the *Conjugatæ*, he not being acquainted with the fact of their formation in the true *Confervæ*:—"During the conjunction of a *Conjugata*, one of the filaments is always giving, the other always receiving; the spires of the giving filament first become confused; and it is not until after the entrance of the matter of that filament that they become irregular in the other, and then the two masses become confounded together, to form the elliptical or spheroidal bodies. The globules of which the spires are composed do not clear themselves the one from

* Annales des Sciences Naturelles, Mai, 1842.

the other during the slow emanation of the matter from the giving filament, and no trace of other motion is observed amongst them. On the contrary, it is in the elliptical body, constituted by the mingled contents of two joints, that I believe to have recognized a phenomenon of locomotion analogous to that described previously in reference to *Conferva ærea.* After many fruitless researches, made for the purpose of seeing the elliptical body develope itself into a new filament, as Vaucher has described, I clearly saw them, on the contrary, dissolve into numerous sporules, endowed with a very rapid motion. Apart from the phenomenon of union of the filaments, which distinguishes the *Conjugatæ* from all other *Algæ,* the only peculiarity in their propagation is, that the elliptical bodies from which the sporules proceed remain after many months without any change in them, while they dissolve *immediately* in the true *Confervæ.*" My own view of the nature of these elliptical bodies precisely coincides with that of Agardh. They are to be considered, I think, as so many sporangia stored with zoospores, which they retain together and preserve from injury until the period proper for their developement arrives. Each of them is composed of at least two, and, according to Meyen, three membranes, these being formed by the gradual inspissation of the organic mucus enveloping the zoospores. At all events, if they be not sporangia, and if they ever germinate, as some suppose, but which I consider still to be very questionable, a second mode of reproduction, which some have contended for, must be conceded to those plants possessing them; for it is very certain that the *Vesiculifera,* in the different species of which are formed bodies in all respects analogous to those of the *Conjugatæ,* are propagated principally, if not exclusively, by zoospores. This is undeniable, and it is but consistent with analogy to suppose, as Agardh has asserted, that the *Conjugatæ* are perpetuated in the same manner. The observation that they dissolve immediately in true *Confervæ,* does certainly not apply to the true oval or circular organs formed in the true *Confervæ,* with the existence of which Agardh was not acquainted. These are, in all respects,

similar to those of the *Conjugatæ*, and are no less permanent in their nature.

M. Decaisne combats the idea of the disintegration of the spores of the *Algæ* formed by the union of the endochrome of two cells into zoospores. He states the fact, that the contents of the spores are fluid. This argument is, however, by no means conclusive; the contents of the undoubted zoosporous *Algæ* are, also, for the most part, fluid; when, however, the full developement has been attained, the fluid disappears, and the cells are filled with zoospores. The same may occur in the spores of the *Zygnemata* &c., as asserted to be the case by Agardh.

M. Decaisne also, in his "Memoir on the Classification of the *Algæ*," strongly repudiates the idea of a double mode of reproduction. The spores, M. Decaisne regards, as already remarked, as the true and only reproductive bodies of those *Algæ* in which they occur, and asserts that in these *Algæ* zoospores are never formed. M. Decaisne thus clearly expresses himself on this point: "Mais je crois pouvoir avancer aujourd'hui que les zoosporées n'offrent jamais de corps reproducteurs résultant d'une concentration de la matière verte provenant de deux individus."

This generalization of M. Decaisne is surely untenable, for it is perfectly certain that the usual and most frequent mode of reproduction of the *Vesiculiferæ*, in which spores altogether analogous, as before stated, with those of the *Conjugatæ* are formed, is by means of zoospores. The motion and developement of the zoospores of this genus of *Algæ* I have repeatedly witnessed, in such a manner as to preclude all doubt on the question. Now this fact in reference to the *Vesiculiferæ*, which may be relied on, leads to the adoption of one of the following views, either that there is a double mode of reproduction in at least a certain number of those *Algæ* in which true spores are formed, viz. by zoospores and spores, or else that the oval bodies termed spores do become disintegrated, in accordance with the statement of Agardh, into numerous zoospores. On the "spores" themselves M. Decaisne has the following remarks: "After the complete organization of the

reproductive body, the cells are absorbed, at least the spores issue by a rounded aperture which they constantly present at this period. These corpuscles have offered me in this case an ovoid form, and I have seen them without exception issue forth, presenting in advance their colourless extremity." Of the many hundreds of specimens of *Conjugatæ* which I have examined, it has never occurred to me to observe the slightest change in the primary form of the spores or sporangia; *what* they really are seems to me a point yet to be determined, nor have I ever seen the colourless extremity referred to.

The opinion of the production of the same species from two organs so dissimilar in size and form as the zoospores and spores are, is not so startling when the structure of these is closely considered, as at first sight it might appear. The zoospores being regarded as young cells of *Confervæ*, containing only one or two other incipient germs or zoospores, and the spores as cells of larger growth, filled with germs, or zoospores, which have arrived at or near their maturity.

The organ contained within each capsule of the different species of the genus *Vaucheria*, I regard likewise as a sporangium filled with zoospores, the horns near it being identical in function with the vesicle already described. The ciliated ovum formed at the extremity of the filaments of *Vaucheria* is of course different from the capsular bodies. Having thus given a general outline of the more interesting and leading facts connected with the reproduction of the freshwater *Algæ*, we shall next proceed to the consideration of their structure and modes of growth.

The *structure* of the *Confervæ* is exceedingly simple. An outer membrane, transparent as water, invests a number of cells, which exhibit under the microscope not unfrequently a fibrous appearance. These cells do not communicate with each other, although their truncate extremities are always in apposition the one with the other. They contain a thick and generally colourless fluid, in which are immersed, and sometimes scattered irregularly, as in the true *Confervæ*, sometimes

disposed in starlike forms, and sometimes in spires, a number of vesicular bodies, the immature zoospores, and in these it is that the colouring matter of the plant chiefly resides. It is from this viscid fluid, the quantity of which is so considerable, that the *Conferva* derives its nourishment and means of increase, and not, at least so I consider, from the intercellular substance of Mohl, to whose theory an objection occurs to my mind, in the fact that it is not rational to suppose that the nutritious fluid should be placed external to the cavities of the cells, the contents of which it is destined to nourish. Such is the view usually entertained, I believe, of the general structure of the filamentous *Algæ*. The opinion at present held by Mr. Jenner as to their organization differs considerably from that just stated, that gentleman declaring that he has, in the *Zygnemata*, detected a third membrane of a delicate and homogeneous appearance, and that it is by this that the dissepiments are formed, and not by the second, which terminates just at the situation of the joints, between which it does not send down any partition walls. Thus the outer membrane he describes as continuous, the second as a series of short tubes, open at their extremities, placed end to end, and the third as the true cells. Of the accuracy of this ingenious view of the structure of the filaments of the *Zygnemata*, &c. I have not as yet been able to satisfy myself. The investing membrane of the cells, one would suppose, would be essential to the existence of a *Conferva*; yet M. Areschoug, in an excellent article on *Hydrodictyon pentagonum*, states that that curious production does not possess it. In the *Ulvaceæ* the cells are not usually placed in linear series, but are scattered through a gelatinous substance, which is usually furnished with an investing membrane.

As the different cells of a *Conferva* do not communicate directly with each other, each cell may therefore be regarded as possessing a separate and independent existence, inasmuch as it contains all the parts requisite for the formation of an entire *Conferva*. A *Conferva* then may be regarded, like the associated Zoophyte, as a compound or aggregated being; and it is to this aggregation of similar parts that the *Confervæ* owe

their very elegant and beautiful appearance under the microscope. Much of the beauty of those most interesting of all Nature's works, the *Zoophytes*, arises from the same cause.

Connecting the zoospores with each other, we find in most of the *Confervæ* a vascular structure. (See Pl. 17.) In the genera *Vesiculifera*, *Zygnema*, *Microspora**, and doubtless in many other *Algæ*, the zoospores up to a certain period of the developement are connected with each other, and probably with the central cytoblast, by means of a tubular or vascular network, in the angles formed by which the zoospores are situated. This structure is most manifest in *Conferva crispata* and its allies, and requires, in order that it may be clearly seen, that the developement of the species should be considerably advanced, and the zoospores somewhat scattered. It may generally, however, be easily detected in the genera *Vesiculifera* and *Zygnema*. In the latter the tubular formation is not arranged in a reticulated manner, but occupies the centre of each spiral thread. It is by the inosculation of the tubular radii given off by the central cytoblast with this vascular structure, that a direct communication is established between that organ and the zoospores.†

In addition to the membranes above described, the zoospores, with the vascular network, the sporangia, and the central cytoblast, two other organs have been noticed in the *Confervæ*, first by Mr. Bowerbank in a species of *Zygnema*, which I transmitted to him, and subsequently by myself in a variety of other species. The one is cruciform and adherent to the interior wall of the cell. (See Pl. 17. fig. 1, 2, 3.) It (Mr. Bowerbank remarks) "is the vegetable structure which secretes the raphides." They are probably not definite organs, but crystals. The other body is small, elongated, somewhat curved, and attached to, or lying upon, the plant. (See Pl. 17. fig. 1, 2, 3.) This (Mr. Bowerbank observes) is certainly "a string of minute cytoblasts; and similar bodies, but more

* Cladophora *Kützing*.

† See "Annals and Magazine of Natural History," vol. xii. p. 20., for a paper entitled, "Observations on some Points in the Anatomy and Physiology of the Freshwater Confervæ."

curved, are observed in the soft parts of the young lips of shells, both marine and freshwater." Several of each of these organs may be found in each cell.

All the separate and distinct structures and parts entering into the formation of the *Confervæ* have now been treated of: certain peculiar adaptations and contrivances still remain to be described, such as the inversion of the extremities of the cells in many *Zygnemata*, the corrugated cells of the *Vinculiferæ*, the layer of fibres surrounding the main stems of some *Batrachosperms*, the ciliary processes met with in the same genus and others nearly allied, and the presence of silex in some *Diatomaceæ*. The further notice of these, however, will be postponed until the individual genera come under consideration.

The rapidity of the *growth* of *Confervæ*, and indeed of all the articulated *Algæ*, has often been a subject of surprise to many observers of Nature; and to none more than myself has it occasioned greater astonishment, until I became acquainted with the reason of so surprising a developement of structure. If the filaments of *Zygnema nitidum* be carefully examined and contrasted together, it will be seen that in some the length of the cells only just exceeds their diameter, and that each cell usually contains four spiral coils, which together perform from seven to eight turns in each, the coils almost touching each other: that in other filaments the length of the cells is more than three times the diameter, but that still each cell contains only the same number of revolutions of the spires, viz. seven or eight, which now, instead of being nearly in opposition, are widely separated; thus plainly proving the elongated cells to be derived from the extension of the shorter ones. And again it will be noticed in other filaments, that the cells have returned to their original length, but that each now contains only three or four spiral turns, thus affording manifest proof of the division of the elongated cells, and completing the chain of evidence which establishes to demonstration the existence of the modes of growth to which I have referred throughout all the cells in the species of the genus *Zygnema*. The proofs now to be adduced, that

this mode of growth likewise takes place in all other *Confervæ* consisting of a single series of cells, are little less conclusive than those just enumerated. In most of the filaments of these, the cells will be observed to be of various lengths, some twice as long as others, and others again of every intermediate length. Now, by means of this law of growth, the variation in the length of the cells is at once and satisfactorily accounted for, which is not to be done in any other way. But this is not all; the progress of the formation of the septa which divide the cells may be frequently traced, a contraction of the cuticle and a division of the endochrome gradually occurring, which is alone sufficient to establish the reality of this law of increase or multiplication of cells in all the true *Confervæ*, and which may be stated to extend likewise to all the other *Algæ*—the *Ulvaceæ*, *Desmideæ*, and *Diatomaceæ*. In those *Desmideæ* however which are not filamentous, but which are formed of two symmetrical cells, the multiplication by growth is often very different. On the separation of the cells from each other, each will throw out a mass of viscid mucous matter, which will go on increasing until it finally takes on all the characters of the primitive cell. Now, particular stress should be laid on this law of developement, since it is evidently very important, inasmuch as it not merely so satisfactorily and so beautifully accounts for the rapid growth of all articulated *Algæ*—for it is simultaneously in operation in each of the many hundred cells of which each filament is usually composed — but it teaches us likewise that much caution is requisite in employing the character of the length of the cells for determining species, as it proves that this character, which used formerly to be much relied on for the purpose, is one subject to very great variation. There is a limit, however, to this law of developement which does not in the genus *Zygnema* allow of more than one or two divisions of each cell, unless indeed the spiral tubes grow likewise in an equal ratio, which may be the case, and then the division of the cells may be frequently repeated. In those *Confervæ* which do not contain spiral tubes the multiplication of the cells may go on to an almost endless extent.

Since the above observations were written *, my attention has been directed by Mr. Francis to a lecture by M. Morren, inserted in the "Bulletin de l'Académie Royal des Sciences de Bruxelles," for 1837, from the perusal of which it appears that the growth of many *Confervæ* by the division of the cells has been noticed by more than one observer. From this lecture I make the following extracts: —

"In 1832, M. Dumortier published his memoir upon the structure and developement of plants and vegetables, in which he established with the greatest clearness the fact of the increase of a number of cells by division. His researches were carried on upon *Conferva aurea*, in which the *terminal* cell elongates itself more than the others, in order to form in its interior an intermediate production (partition), which divides the cells into two parts, each becoming a new cell." No one could be more explicit, observes M. Morren, who goes on to say, "the division of cells by intermediate membranes was examined likewise by M. Hugo Mohl in September 1835, upon *Conferva glomerata*, &c., a *terminal* cell of which showed near its centre the commencement of a diaphragm proceeding from the circumference towards the centre." This is in all respects, M. Morren remarks in continuation, the observation of M. Dumortier, but upon another species, and it is all simply the fact previously noticed by myself upon *Cruciagenia*, but transported from the *Diatomaceæ* to the *Confervæ*.

From this it appears that M. Morren would claim for himself priority in the discovery of the increase of cells of *Confervæ* by division, but the single observation published in August 1830, upon the genus *Cruciagenia*, an *Alga* differing much in structure from true Confervoid productions, would hardly suffice to establish for M. Morren this claim any more than would the observation of Mirbel on the division of the pollen cells give him a claim to the discovery

* The substance of the preceding remarks, on the growth of the *Algæ*, is extracted from a portion of an "Essay on the Confervæ," read before the Dublin Natural History Society and inserted in the "Annals and Magazine of Natural History," vol. i. p. 431.

of the manner of the multiplication of the cells of *Confervæ*. Moreover, the investigations of MM. Dumortier and Hugo Mohl do not go further than to prove, except perhaps the remarks of the latter in reference to one species of the genus *Zygnema*, that the *terminal cell* of each filament is successively undergoing division, and not the far more important fact upon which I have so particularly dwelt, that *all the cells* of a *Conferva* or articulated *Alga* are constantly and almost simultaneously undergoing a similar process of multiplication by division.

M. Morren afterwards observes in his lecture: "In my memoir on the *Closteria*, inserted in the "Annales des Sciences Naturelles (partie Botanique), Mai, 1836," I showed that the colouring matter, the endochrome, in consequence of polarization, divides itself in each cell into two opposite masses, which become separated by the secretion of a transparent liquid (a true intercellular substance, in which is formed the double diaphragm, which by separating produces slowly the dislocation of the two cones of the *Closterium*.

"I have since observed," continues M. Morren, "all the particulars of this phenomenon of the formation of intermediate partitions in the *Confervæ*, my observations having been made on *Conferva dissiliens*. The articulations in this are very short, equalling their diameter or even less than this. Now there is in these a green mass at first uniform, in which appear peculiar globules, which become transparent vesicles, more yellow than the rest of the colouring matter, presenting finally spots more obscure, almost brown or red at the centre. These bodies appear to me to be the male apparatus exercising a true fecundation upon the rest of the endochrome. But this mass, when the male cellules are developed, polarizes and flows towards the two poles of the parent or general cell. Then this cellule is seen to become elongated under the dominion of this ebbing or polarization, and between these two masses a transparent space is manifest. The compressorium has proved to me that there is here a mucous fluid or intercellular substance. Now upon the periphery of this substance the condensation operates; at first little by

little it proceeds towards the centre, and in place of a zone of liquid substance there is a membrane duly organized and fit to become divided into two membranes, each mass of endochrome having its wall, or more correctly, its proper membrane." In this account no mention is made as to whether the cells, the division of which M. Morren witnessed, were terminal or not.

My own views of the phenomenon of the division of the cells of *Confervæ*, and of the explanation to be offered of it, differ considerably from those of M. Morren. All the cells of a *Conferva*, until it has reached a state of maturity, are *continually increasing in length;* and it is only in certain cells which have exceeded their standard length, that the gradual separation of the endochrome into two masses is seen to occur, and a transparent space to be left between them; this space is not, however, in my opinion, occupied by any formative intercellular matter, such as that referred to by M. Morren, who, in his explanation, asserts that the polarization and separation of the endochrome *first takes place*, and that afterwards the cells begin to grow. The first indication of the formation of the partitions which are to divide the parent cell into two, is not visible until after the separation of the endochrome, and appears to consist in a solution of a portion of the periphery of the centre of that cell, the divided edges of the cell then becoming inverted separately, and growing towards the centre, where they coalesce. Thus, according to this view, the partitions of the cells are not, as M. Morren would assert, new growths or formations,* but merely an extension of the separated margins of the parent cell.

A second mode of development*, of considerable importance as regards the classification and description of the *Algæ*, still remains to be described. In many species of *Confervæ* more especially in the branched kinds, and in numerous other *Algæ;* in the species of the genera *Vesiculifera*, *Lyngbya*, *Meloseira*, *Fragilaria*, &c., there is not only a longitudinal developement of the cells, but there is likewise a lateral growth

* See Annals of Nat. Hist. vol. xi. p. 359.

of them; so that if we examine any species in which this law is known to exist, we shall observe, first, that the filaments differ considerably in diameter in the same specimens; secondly, if the species be a branched one, that the largest filaments are near the centre of the specimen; and, thirdly, that the diameter of all the filaments, whether they be near the centre or circumference, gradually decreases from base to apex; the observation of these three facts proving the existence of the law of the lateral developement of cells, and also showing it to be in the degree of their age. The proportions of a specimen of a branched *Conferva*, therefore, are in miniature those of a tree or shrub. This law has no existence in the conjugating *Confervæ* in the genera *Bulbochæte* and *Desmidium*, and in the majority of *Oscillatoriæ*. One or two other observations still remain to be made in reference to cells, to complete the interesting subject of the developement of the *Confervæ*. Prior to the discovery of the multiplication of cells by division, the opinion was generally entertained that each cell was at its commencement very small, and that it increased little by little, until it attained its perfect developement; and this is the case with the cells of parenchymatous tissue; but in the examples where the multiplication of cells takes place by division of those cells which have already become great, nature takes a means for the fulfilment of its end, altogether different, but not less effectual.

It has already been mentioned that the different series of cells of which the *Confervæ* are composed, are all enveloped in a continuous membrane, which serves to bind them together; there would appear, however, according to the researches of Agardh and Hugo Mohl, to be another and direct bond of union between the cells, not merely of the Algæ, but of all other plants, this consisting in an adhesive substance which Mohl has denominated "intercellular," by which they are firmly united to each other. The same substance is found coating the surfaces of the pollen granules, binding them into masses.

Having thus traced the developement of the *Confervæ* from

their earliest period, viz. from the condition of zoospores, and having examined their structure and modes of growth, we shall next proceed to make a few remarks upon their distribution and vitality.*

Not amongst the least beautiful of the many minute organizations, whose intimate structure the microscope, which has so wonderfully extended of late our knowledge of the natural world, has revealed to us, are the freshwater *Algæ*, and yet the majority of these constitute the rejected and despised, by all but the true naturalist, scum and slime of our still and soft waters; but although many freshwater *Algæ* are, for an obvious and benevolent purpose, hereafter to be mentioned, ordained by their Great Designer to be the tenants of our impure and stagnant waters, there are other species which are met with only in fresh and running streams, adhering by one extremity to some object of attachment, the other floating freely in the surrounding fluid medium in the course of the stream, whose impetuosity and strength these frail productions seem at first sight but ill able to withstand. They find their protection, however, not less in the flexibility than in the tenacity of their structure. This is the case with the *Lemaniæ*, *Lyngbya crispa*, and with the beautiful *Conferva glomerata*, which delight in the purest and most rapid streams. The *Ectosperma clavata* of Vaucher, known by its globular form and dark green shining appearance, is met with only in the course of the waterfall or cataract, sustaining unharmed the whole force and weight of the foaming waters which pour over it. The *Batrachosperms*, the most elegant of all our freshwater *Confervæ*, also usually dwell in pure water, but are obliged, for the most part, from the delicacy of their conformation, to confine themselves to such streams and rivulets as are slow, and possess but little strength; while some *Confervæ*, as many species of *Zygnemata*, *Tyndaridea* and *Mougeotia*, are almost exclusively confined to marshes, ditches, or shallow and extended pools,

* For a highly interesting memoir upon the connection of the cells of plants, by Hugo Mohl, see Annales des Sciences Naturelles, second series, tom. viii. (Botanique).

which dry up and disappear at the approach of summer, the species inhabiting them having performed their allotted office in the economy of nature, disappearing likewise, their lives terminating with the exigency which called them into existence; others are usually met with in the perennial waters of our deep and clear lakes and ponds, and, though not themselves perennial, yet have probably a life of somewhat longer duration extended to them; as, for example, some of the larger *Zygnemata*, certain species of *Draparnaldia* and *Lyngbya* and *Conf. crispata*. I am inclined to think, however, that the lives of but few species of freshwater *Algæ* extend beyond the period of a year, while it is very certain that very many perish in a few months, or even weeks, from the time of birth, in which case I can assert from observation, that the species perishing thus early are frequently reproduced in the course of the summer, when the circumstances are favourable, some two or three times. Very many *Confervæ* die in the spring from the drying up of the waters in which they dwell, at which season it is wisely ordained that such species should mature their seeds; amongst these may be mentioned many species of the genera *Zygnema*, *Tyndaridea* and *Vaucheria*; others die at the approach of winter, but not all; a few linger through the greater part of this season so unfavourable to the exercise of the vital functions of plants. There are other species, again, which do not require to be constantly immersed in water, but are found upon those soils and in situations which retain moisture for some time, as upon shaded and clayey pathways, at the roots of trees, on banks, thatch, and at the bottom of palings, the drippings from which they receive. In such localities, *Conf. ericetorum*, some *Lyngbyeæ*, *Scytonemeæ*, many *Oscillatoriæ* and *Nostochineæ* are met with. In these plants, the strength of the vital principle must be very great, for their filaments may be dried up for a considerable time; but on the application of moisture, they soon recover their healthy appearance.

So abundant are the productions under our consideration, that there is not a ditch or pool of any extent or standing

but furnishes one or more species, and even our mineral springs are not entirely free from them. From the uniform nature of the element which the majority of the freshwater *Algæ* inhabit, it may be confidently anticipated that very many of the species described in this work will, when the *Algæ* come to be studied with that diligence and care which they so well merit, be found in most of the continental countries. Of the species described by Vaucher, a considerable proportion are likewise indigenous to Great Britain.

Most of the freshwater *Confervæ*, when in a healthy state, are of a green colour, the shade being often extremely rich and beautiful, but varying with the condition of the species, and with the species themselves. The occurrence of this colour is comparatively rare amongst the marine *Algæ*, in which it is usually more or less red or brown, the colouring matter being operated upon probably by free acids in the salt water.

Sometimes the *Confervæ* are diffused through the waters of a pond or lake, imparting to it a bright green colour, and causing it to resemble so much of the purer element—the sea. At others, the filaments of a number of different species will become entangled, and float together upon the surface of the water, wafted hither and thither by the wind, like a beautiful cloud, the softness and richness of the tints of which a painter would be immortalized could he imitate. It is only during the early spring months, however, that the *Confervæ* retain this depth and beauty of colouring; for under the influence of the rays of the summer sun, they very soon fade and bleach, becoming ultimately, when the water in which they dwell has evaporated, converted into the paper-like substance which has recently attracted so much attention on the Continent; indeed, so like to artificial paper is this natural formation, that I feel assured an useful paper might, by an artificial process, be made during the summer months out of many abundant species of *Confervæ*.

The *Confervæ*, like most other productions, whether animal or vegetable, whose organization is feeble, cling tenaciously to life; thus, they may be torn and cut up into a thousand

pieces, and yet each separated portion will retain its vitality unimpaired, and go on increasing as before; but this is owing, in a measure, also to the fact of each cell in the series enjoying an independent vitality. They also sustain, unharmed, considerable vicissitudes of weather, notwithstanding which they are, however, regular barometers, rising and sinking in the fluid medium which surrounds them alternately, either as the sun shines, and warmth is diffused, or as clouds and rain obscure the sky, and cold prevails. In this way, too, they protect themselves in a great measure from the alternations of weather, the water being much warmer beneath the surface than on it. This power which the *Confervæ* possess of rising and sinking in water, in correspondence with atmospheric changes, is to be explained by reference to their specific gravity, which is in proportion to the activity with which the function of respiration is carried on. During the autumnal and early spring months, the *Confervæ* remain almost entirely at the bottom of the water, except when tempted by a few sunny days to rise to the surface, and expose themselves to the contact of the air; so that the naturalist engaged in the investigation of these productions is often surprised on visiting ponds in which he beheld the day previously *Confervæ* floating on the surface in considerable quantity, to find that on his next visit they have all vanished. The *Confervæ* are also amongst the first, if not the very first, subjects of creation to feel the approach of more genial weather, beginning to vegetate sometimes so early as the months of January or February.

In the preceding pages it has been assumed that the fresh-water *Algæ* are really what many observers have been inclined to doubt, viz. vegetable productions or plants, they being led so to do, first, from the curious and extraordinary motions of the zoospores already described, and second, from the peculiar and animal fœtor which the different species exhale during decomposition. Their true position in the scale of organized beings has been, it seems to me, satisfactorily determined, not merely by reference to certain resemblances which they bear to vegetables in appearance and

organization, but also and mainly by chemical analysis. In the 14th volume of the second series of the "Annales des Sciences Naturelles (Botanique, 1840)" is an elaborate and highly interesting memoir by M. Peyen, on the chemical composition of vegetable tissue. In this memoir, M. Peyen establishes a distinction between animals and vegetables based upon the chemical difference which he has ascertained to exist between the cellular membranes of the respective divisions of the organic world. The vegetable tissue, M. Peyen finds, to exhibit invariably a TERNARY composition, that is, it is composed of three out of the four elementary constituents of which all bodies are formed, viz. carbon, hydrogen, and oxygen in nearly fixed proportions, as follows: — carbon 44, hydrogen 6, oxygen 50. The composition of the animal tissue or membrane, on the contrary, is as invariably QUATERNARY, or formed of all the elementary constituents in less fixed proportions. This generalization is arrived at by an extensive and careful analysis, not only of animal substances, but also of examples of most of the families and orders of Phanerogamic and Cryptogamic plants. Amongst the freshwater *Algæ* an analysis was made of *Conf. rivularis*, *Oscillatoria*, and *Chara*, these all offering the same result as the other analyses of vegetable tissue, and therefore being conclusive as to the vegetable character of the Confervoid division of the *Algæ*. It is to be regretted that an analysis was not made of the *Desmideæ* and *Diatomeæ*, with a view to determine more certainly than has yet been done their position in the scale of beings. That the *Desmideæ* are really vegetable productions, scarcely a doubt remains, iodine demonstrating the presence of starch in abundance in the contents of their cells.

The following are the steps adopted by M. Peyen in order to free the membrane of the *Conferva rivularis* and *Oscillatoria* from all extraneous matter, and thus to prepare it for analysis: —

"I tried next to test, with the same object in view, very many *Confervæ*. Soda, by dissolving with heat the investing membrane of the filaments of *Conferva rivularis*, separated

from each other the long cells, which, applied end to end, and more or less filled with green matter, occupy all its tubular capacity."

"In order to remove entirely the green matter, it was necessary to open the cells which retained or held it, by means of dissolvents. I contrived to effect this by squeezing slightly together moistened *Confervæ*, drying the mass, afterwards submitting it to the action of lime, then alcohol, ammonia, solutions of soda and potass diluted, removed the azotized substances and green matter in solution. Chlorine effaced the last traces by eliminating also a brown substance; hydrochloric acid, water, ether, and alcohol perfected the purification by removing carbonate of lime and fatty substances. The purified membranes of *Conferva rivularis* and *Oscillatoria* presented then the composition of the other vegetable tissues."

The nature of the contents of the cells of the *Confervæ* is, it would appear by the preceding remarks, more complicated than one would be led to suppose from a consideration of the structure of the cells themselves. Starch is found in them in considerable quantity, azotized substances, a fatty matter, a colouring substance, and an odoriferous principle, as well as salts. The *Chara*, M. Peyen remarks, contains granules of starch, green azotized bodies, soluble azotized substances, a fatty matter, a colouring substance, an odoriferous principle, recalling the marshy odour of many *Confervæ*, chloride of potassium, carbonate of lime adherent to the exterior of the membrane, and silica.

Nitrogen, as is now well known, is the animalizing principle. It is found, however, not as an organic constituent, but merely as a product in small quantities throughout the vegetable kingdom. It is especially noticed in the seeds of the *Gramineæ*, in the *Fungi*, and in the delicate reproductive organs, in the pollen, &c. As a rule it has been remarked that its presence is constant in the young parts and organs of plants in which there is always a high degree of vitality, in the establishment and maintenance of which this substance would appear to be an essential element. M. Peyen, in the

Memoir already referred to, lays down the following proposition with regard to nitrogen.

"In the two kingdoms, the bodies which admit azote to the number of their principal constituents, are indispensable to the accomplishment of the laws of life."

A distinction may be established between animals and vegetables, moreover, by a consideration of the effects of different reagents applied to their tissue. This distinction is, however, less satisfactory than that derived from a knowledge of their chemical composition. "Vegetable membranes," M. Peyen remarks, "which are well aggregated, are not sensibly alterable in the presence of a host of reagents, such as iodine, chlorine, the alkalies, and acids diluted, tannin, many neutral salts, alcohol, and creosote, which colour, attack, dissolve, or strongly contract the membranes of animals, but the distinction which is founded upon their elementary composition is still more certain."

The same agent, iodine, seems to detect the presence of the product starch, and of the element azote, by imparting to starch globules a blue tint, and to those substances containing azote a yellow coloration.

A few remarks upon the subject of circulation may here be introduced. If we except the order *Characeæ*, to be described in its proper place, but few traces of a circulation in the freshwater *Confervæ* exist. There is probably a motion of fluid in the tubular structure which connects the light green granules of the *Algæ*, and in the rays which proceed from the central organ in *Zygnema*; there is also, doubtless, an action of endosmosis and exosmosis carried on between the different contents of the cells, and between these and the water in which the *Confervæ* dwell.

The uses of the freshwater *Confervæ* may be regarded as fourfold; two of these uses pertain to the animal creation in general, the other two to man in particular.

The first and most obvious use to notice is, the abundant supply of delicate and nutritious food which they furnish to myriads of the inhabitants of our fresh waters. It is scarcely

possible to place a fragment of any *Conferva* under the microscope, without perceiving some of the numerous forms of life which dwell amongst its filaments; and the structure of many of which is so beautifully adapted to the wants of the creatures, and to the existence which they are destined to lead, as to raise in the mind of the beholder the liveliest feelings of admiration.

The second purpose to which the *Confervæ* are subservient is one of great importance, being the purification of the fluid in which they dwell, laden, as it frequently is, with various deleterious gases, arising from the death and decomposition of various animal and vegetable substances; thus deriving their own origin, for the most part, in the midst of impurity, they are the agents employed in removing this impurity, which salutary office they perform in the following way. Amongst the most noxious of these gases to animal life are carbonic acid and carburetted hydrogen; now carbon, the base of these, constitutes the pabulum, or food, of plants. These two gases, then, the *Confervæ* decompose, retaining the carbon for their own support, and setting free the oxygen and hydrogen; thus not merely decomposing and removing what is hurtful, but restoring to the water oxygen, the essential to all animal life whether found in air or water. Seeing, then, the important purpose which these apparently frail and insignificant productions fulfil, who is there who would venture to remove even this one small and remote link from the chain of Nature's works, and would be answerable for the consequences of its removal? Who can tell what baneful influence might not arise, and spread disease and death through whole districts? a calamity which, even as things are now ordained, is occasionally permitted to overtake us. Should any individual be sceptical as to the influence of these productions, and whether a respiration of the kind I have alluded to, and attended with the same results, really occurs, let him put into a tumbler of water a little of the first *Conferva* which he may meet with in his next ramble, and, placing it in the rays of the sun, watch it for a short

time; he will soon observe globules of a gas, at first small, but soon becoming larger, to collect upon the surface of the filaments, which, when they have attained a sufficient size, will quit their attachment, rise to the surface of the water, and at last lose themselves in the surrounding air. This will, I think, satisfy him that a respiration of some kind is carried on; and should he wish to ascertain the nature of the gas thus eliminated, whether it be really oxygen or not, this may be done by procuring a considerable quantity of any floating species of *Conferva*, and placing it in a trough of water, over which should be put a glass jar also filled with water, having an air-tight collar adapted to it, so disposed as to catch the gaseous globules as they ascend. As soon as the glass jar becomes filled with the gas, let the air-tight collar be removed and a piece of ignited phosphorus be quickly plunged into the interior of the jar, when the brilliant and dazzling combustion which will instantaneously ensue will afford a proof conclusive of the nature of the elimination. The honour of this discovery, if it can be deemed one, for it is but the extended application of the common principle of the respiration of plants generally, is in this country attributed to Priestley; but so obvious is it that it scarcely required the penetration of a mind like his for its detection: Vaucher alludes to it cursorily.

The third use of the *Confervæ* is a moral one. Every created thing, rightly viewed, is capable of imparting this moral lesson, be it the kingly lion or the spurned reptile; the beautiful and scented flower, or the more humble productions which have been engaging our attention. There is no imperfection acknowledged in nature, nor are there, strictly, degrees of comparison; everything is superlative, is best and perfect from the hands of God who made it, alike unsurpassable and inimitable.

Then, lastly, there is the intellectual benefit derived by those who study this or any branch of Nature's works. There are those who regard the pursuits of natural history as trivial and tending to no useful purpose; but these are but superficial ob-

servers, with hearts and minds alike incapable of appreciating the depths and hidden beauties of the study. I maintain, in opposition to these, that there is room in the contemplation of, and search after, the laws and phenomena of animal and vegetable life and growth, for the exercise of an enlarged and enlightened understanding.

HISTORY

OF THE

BRITISH FRESHWATER ALGÆ.

" Il y a dans chaque plante bien examinée une preuve vivante de l'existence du grand Être que governe cet univers. Les divers arrangements qui présentent les organes sont autant de petits problèmes proposés par la grande Intelligence à notre faible intelligence qui en dérive. J'avoue, au moins pour moi-même, que je n'examine pas une simple fleur sans être étonné de la sagesse qui en a disposé les diverses parties, et sans apercevoir dans le detail, ou dans l'ensemble, le texte de méditations les plus profondes." — *Vaucher.*

" Je crois que la principale utilité que l'on doit retirer de cette étude, se trouve dans les goûts simples qu'elle inspire à ceux qui la cultivent. Le jeune homme qui s'y applique avec ardeur, se dérobe par son moyen aux passions turbulentes du premier âge, et fortifie sans cesse sa santé par des exercises agréables." — *Vaucher.*

ALGÆ FILIFORMES.

Family SIPHONEÆ.

Characters. Algæ *composed of a continuous branched and cylindrical cell.* Reproductive organs *external.*

Genus VAUCHERIA *D. C.*

Char. Frond *here and there occasionally inflated.* Reproductive organs *of two kinds, consisting of capsules and antheræ or horns, lateral or terminal.*

Vaucheria D. C. in Vauch. Conf.; Lyngb. 65. t. 19. 23.; E. B. 1766. 933.; Flor. Dan. t. 1724. 1727.; Grev. Algæ Brit. t. 19. *Ectosperma* Vauch. Conf. t. 2, 3.; Unger in N. A. N. C. xiii. p. 789. 140.; Conf. Sp. Dillw, t. 15, 16. 47. 74.

Of all the freshwater *Algæ* none are more interesting or more curious than those which we are about to describe. It was from a knowledge of the reproduction of this genus, which was first clearly made known by Vaucher, in his excellent work on the *Algæ*, the only monograph at the period in existence devoted exclusively to the consideration of the freshwater division of the tribe, that naturalists were led to entertain the notion of sexes in this class of plants, a notion which even now it is by no means easy in all cases to discard.

The *Vaucheriæ* are first described in this work, because amongst the freshwater *Algæ* they seem to stand alone, exhibiting no distinct relation to any other genus of that division of the *Algæ*, although to the genera *Codium* and *Bryopsis*, amongst the marine species, they manifest a close affinity.

The organs of reproduction of the *Vaucheriæ* are of two kinds, being composed of capsular bodies, and of filaments,

placed close to the capsules, which have been termed anther, from the analogy which they present to the anthers of Phanerogamic plants in situation, and, as some even consider, in function.

The nature of the large oval or spherical bodies, one of which is contained in each capsule invested with its proper membrane or membranes, does not seem to be satisfactorily determined. Vaucher states in his "Histoire," that he has traced their growth and developement into perfect plants; but the observation does not appear to have been placed beyond question by the additional testimony of other witnesses.

With respect to what Vaucher terms the horn, from its curved appearance, although he would seem to have entertained but little doubt that it really performed the office which he assigned to it, viz., that of an anther, nevertheless, he was unable to bring forward any direct proof that it did so; and this he appears himself to have acknowledged and regretted, as will be seen from the following passage:—"Nevertheless, I am not sufficiently certain of the functions to which the horn which accompanies the seeds is applied. It is in truth constantly placed in the neighbourhood of the grains, and it is seen, especially in *Vaucheria* (*Ectosperma* Vauch.) *ovoidea* to shed its powder; that is incontestable; still I have always desired some direct evidence which should convince me of the use of this horn."

That the horn has an office to fulfil in relation to the spores or sporangia, none can doubt who consider its almost constant presence, the situation which it occupies with reference to them, the shedding of its granular contents, and the subsequent changes which it undergoes indicative of its having performed the duty allotted to it. What the exact nature of this duty is, cannot as yet be determined, although every additional observation which has been made tends to strengthen and confirm the view of its function adopted by Vaucher, viz. that it is the organ by which fertilization is effected. The truth of this statement will be evident from the following remarks:—

In page 17. of Vaucher's "Histoire des Conferves d'Eau

douce," the following observations occur. Alluding to the horns, Vaucher observes — "At first they are straight and opaque, and consequently contain the green fecundating matter; gradually they incline towards the grain, and surround it, so that they rest upon it to shed their powder. When the seed is separated, they are empty, and assume a spiral form; and what confirms me still more in the opinion, that the horns fulfil the functions of stamina is, that all the *Ectosperms* which are provided with them have no other enlargement, and that, on the contrary, those which have other enlargements are altogether destitute of the horns."

If the horns approach the seeds in some cases, the converse is true in others; and the propriety of this will be evident when we consider the position of the horns with reference to the grains or germs in some species. In *Vaucheria geminata*, the germs which are furnished with peduncles approach the horns, in contact with which they remain for some hours, and then gradually they raise themselves from it, and the peduncles which support them curve backwards away from the horns. This gradual approach of the grains to the horns, and their subsequent retraction from them, strengthen the conclusion that this organ is necessary to the grains. For Vaucher's assertion to be correct, that the horns approach the grains in the case where there is but one anther, situated midway between two spores, it would first have to turn towards and reach the one spore, and then act in like manner towards the other; the improbability of which is self-evident; but, on the other hand, how simply are the germs brought within the influence of the horn by their approach to it on each side.

The "other enlargements" in which the horns are absent, referred to by Vaucher, I presume to be terminal enlargements of the threads, as in *Vaucheria clavata*, and which are altogether of a different nature from the capsular bodies described. Oval inflations of the filaments do also occur occasionally: the presence of these, however, is by no means constant, and they do not seem to be in any way connected with reproduction.

Additional evidence in favour of the influence exerted by the horns consists in the fact of the capsules or seed-vessels being either perforated or prolonged into a short tube, just at the place where it comes in contact with the horn. This aperture may fairly be presumed to be intended to facilitate the admission to the spores of the granular matter discharged by the horns.

Allusion has already been made in the Introduction to the powers which many *Confervæ* possess of resisting low degrees of temperature. The spores of the different species of *Vaucheriæ* would appear to be endowed with this power to a remarkable extent. "In spite of all my precautions, the frost of winter reached the water of my vase, and my grains became enveloped (*engagées*) in very thick ice. They remained thus until the period of the thaw, that is to say, during fifteen days, and when they reappeared, I believed them at first to be too much injured to hope for any success; but I called to mind very opportunely the experiments of Spallanzani upon the different degrees of cold which seeds would bear, without losing in consequence the faculty of germination; and well convinced that the *Confervæ* exposed to the open air had not been more fortunate than mine, I resolved not to abandon my observations." The observations were continued; and, as states the text, the grains germinated, to the infinite delight of Vaucher.

This faculty of resisting cold is bestowed upon the *Vaucheriæ* and many *Confervæ*, and especially upon their seeds, with the evident design of guarding against the extinction of the species, which would be almost certain to occur upon the freezing up of the waters of the ditches in which they are usually found. The power also which these plants, and especially their seeds, retain of sustaining high degrees of temperature, is scarcely less remarkable, and is doubtless imparted to them with a similar provident intention. This power in the case of the spores is to be explained by reference to the compact capsule which surrounds them, and which prevents the evaporation of the interior moisture. Another precaution adopted by nature to guard still further against the risk of the extermination of any species, is the fact that very many *Confervæ* (the *Vaucheriæ* included), and

especially such species as inhabit shallow and extended waters, mature and shed their seeds prior to their drying up, and that the special period of their doing this varies in a measure with that of the exhaustion of the water.

Further research will doubtless disclose many other species in addition to those described to be inhabitants of the fresh waters of Great Britain. Few species of the genus *Vaucheria* dwell in the sea. They bear, however, a close analogy to the marine genera *Bryopsis*, *Codium*, and especially *Ectocarpus*. M. Decaisne places the *Vaucheriæ* in his class *Aplosporeæ*, a class in which the *Batrachospermeæ* find a place. They are much more nearly related to his *Sunspores*, than to the family of *Batrachosperms*.

a. *Vesicles lateral, solitary.*

1. VAUCHERIA DICHOTOMA *Ag.**

Plate IV. Fig. 1.

Char. "Frond *setaceous, dichotomous, fastigiate.* Vesicles *solitary, globose, sessile.*"— Grev.

Hooker's Brit. Flor. vol. ii. p. 319.; *Conf. dichotoma*, English Botany, t. 932.; Harvey's Manual of British Algæ, p. 147.; Berkeley's Gleanings; Dillwyn's British Confervæ, t. 65.

Hab. "In ponds and ditches; frequent; annual; spring and summer."

"Fronds setaceous, a foot or more in length, dichotomously branched, forming wide strata at the bottom of pools, and frequently filling them; colour, a pale yellowish green, and occasionally dark."—*Harv.* I much doubt whether this is anything more than a condition of *Vaucheria sessilis*, the capsule being of precisely the same form as in that species, and upon undoubted specimens of which it is by no means uncommon to find solitary capsules. A yellowish or olive green is the colour of all the species of the genus when aged and in seed.

* The abbreviation of the name of the individual affixed to the specific denomination of any production does not necessarily imply more than the fact, that the person thus alluded to was the first to place that production in the genus with which it is in this work described.

2. Vaucheria Dillwynii *Ag.*

Plate IV. Fig. 3.

Char. Frond *flexuous, terrestrial.* Vesicles *sessile, globose.*

Grev. Alg. Brit. p. 191. t. 19.; Hooker, Brit. Flor. p. 320.; *Conf. frigida,* Dillwyn's British Confervæ, t. 10.; *Conf. frigida* Roth, Cat. Bot. 1. p. 166.; Harvey's Manual, p. 147.; Fl. Germ. 111. p. 491. *Conf. amphibia fibrillosa et spongiosa, C. terrestris exilis fibrillosa,* Ray's Synopsis, p. 59. n. 7.

Hab. Cheshunt: *A. H. H.* Sussex: *Mr. Jenner.*

This species is by no means uncommon, forming patches of a bright green colour, on moist and clayey ground. This *Conferva,* Mr. Dillwyn observes, is not unfrequently found in turnip fields during the winter and early months of spring, particularly in a northern exposure, and on a cold soil. The patches vary in size, but are usually two or three inches in extent, adhering but slightly to the soil, and consisting of loose, unconnected filaments. The form of the capsules, which are rarely pedunculated, will at once distinguish this from all other species which have hitherto been described.

3. Vaucheria repens *Hass.*

Plate VI. Fig. 7.

Char. Frond *terrestrial.* Capsules *avicular, or in the form of a bird's head.*

Hassall, in Annals of Natural History, vol. xi. p. 430.

Hab. Growing on a footpath near Royston, Essex, Feb. 21st, 1843.

This forms patches upon the moist earth, like the preceding, from which it is not to be distinguished without the aid of a lens. The form of the capsules, as seen in the figures, is very different from that of *Vaucheria Dillwynii,* and by it the species may at once be known. I have only once met with it.

4. VAUCHERIA HAMATA *Vauch.*

Plate V. Fig. 1.

Char. Capsules *ovate, pedunculate, overhanging the incurved anther.*

Ectosperma hamata Vauch. Hist. des Conf. d'Eau douce, p. 26. pl. ii. fig. 2.; Hassall, in Annals of Nat. Hist. vol. xi. p. 439.

Hab. Vicinity of Cheshunt; not uncommon.

This species is very distinct, and first occurred to me at Cheshunt, in a ditch half filled with water, in company with *Vaucheria geminata.* "It differs from all the others by the manner in which it carries its grains. The peduncles which sustain them are much elongated, and they bear at their extremity two little threads: the one is recurved and receives the anther, the other is shorter and straighter, and carries the grain."—*Vaucher.*

5. VAUCHERIA TERRESTRIS *Vauch.*

Plate V. Fig. 2.

Char. Frond *irregular, terrestrial.* Capsules *pedunculated, resting almost directly on the recurved anther.*

Ectosperma terrestris Vaucher, Hist. des Conf. p. 27. pl. ii.; Grev. Alg. Brit. p. 191.; Hook. Br. Fl. p. 320.; Berk. Glean. Alg. t. 9.

Hab. Cheshunt: *A. H. H.* Shady places, frequent, Sussex: *Mr. Jenner.*

This *Vaucheria,* like *V. Dillwynii* and *V. repens,* is also terrestrial, and like them also forms patches on damp and clayey soil, which frequently present a bristled appearance, occasioned by a number of short and vertical branches, which arise from the horizontal creeping fibres.

The species bears some resemblance to the preceding; the peduncle is larger, coarser, and not so forked as in it, and the

seed-vessel, which is of smaller size, rests almost immediately on the incurved anther.

Found in fructification, according to Vaucher, in the autumn; my specimens were obtained in a hedge at Cheshunt in March, and were also in fructification.

b. *Vesicles lateral, sessile, geminate.*

6. Vaucheria aversa *Hass.*

Plate VI. Fig. 5.

Char. Capsules *usually in pairs, and in the form of a bird's head, with the beaks averted from each other.* Sporangia *circular, not entirely filling the cavity of the capsule.*

Hassall, in Annals of Nat. Hist. vol. xi. p. 429.

Hab. Vicinity of Cheshunt.

I have now met with this species repeatedly; it is one of the best marked and most peculiar of the genus, the beaks of the capsules being turned in opposite directions at once, distinguish it from all other known species, in which, when the vesicles are in pairs, they are directed towards each other. This averted position of the capsules renders the existence of a distinct horn or anther essential for each. In the form of the seed-vessels, and in the circumstance of the sporangia not filling the entire cavity, the species resembles *Vaucheria ornithocephala.*

7. Vaucheria ornithocephala *Ag.*

Plate VI. Fig. 4.

Char. "Vesicles *binate or quaternate, with a short beak, and pellucid border, upon short, straight peduncles.*"— Harv.

Grev. Alg. Brit. p. 193.; Hooker, Brit. Flor. p. 320.; *Conf. vesicata* Dillw. Brit. Conf. t. 74.; Harv. Manual Brit. Algæ, p. 148.

Hab. Near Bristol: *W. W. Young.* About Edinburgh: *Dr. Greville.*

This species would appear to be one of the rarest of the genus. I have myself never encountered it.

8. Vaucheria sessilis *Vauch.*

Plate IV. Fig. 2.

Char. Capsules *pyriform, large, sessile.*

Ectosperma sessilis Vauch. Hist. des Conf. d'Eau douce, Grev. Algæ Brit. p. 192.; Hook. Br. Fl. p. 320.; Eng. Bot. t. 1765.; Harv. Manual, p. 148.

This is one of the most abundant species of the genus. The vesicles are almost as often solitary as in pairs; and in this state I apprehend it constitutes the *Vaucheria dichotoma* of writers. The spores are frequently noticed to be of a reddish colour. This appearance is common to all the species of the genus, and is probably the result of age, and also an indication of the presence of azote.

c. *Vesicles pedunculate, in pairs, lateral.*

9. Vaucheria geminata *Vauch.*

Plate III. Fig. 1.

Char. Capsules *situated on a divided peduncle, common to both.* Anther *intermediate.*

Ectosperma geminata Vauch. Hist. des Conf. p. 29. pl. ii. fig. 5.; Grev. Algæ Brit. p. 193. t. 19.; Hook. Br. Fl. p. 320.; Eng. Bot. t. 1766.; Harv. Manual, p. 148.

The filaments of this species are much finer than those of any of the preceding; the seed-vessels, too, are smaller, and represent a sphere hollowed out on the inner side, or towards the anther. The peduncle is common to both seed-vessels: after ascending for some distance from the filament from which it rises, it sends off laterally two branches, on each of

which a capsule rests, the continuation of the peduncle forming the anther.

Occasionally it happens that the capsules are sessile, and the plant bears some resemblance to *Vaucheria sessilis;* it differs, however, in being altogether much smaller, and in the form of the capsules.

It was first discovered in England by W. Borrer, Esq., as far back as 1807. It is by no means uncommon throughout England.

d. *Capsules in clusters, lateral, pedunculate.*

10. VAUCHERIA RACEMOSA *Vauch.*

Plate III. Fig. 2.

Char. Capsules *usually four in number, placed upon a peduncle common to all, which terminates in a single* anther.

Ectosperma racemosa Vauch. Hist. des Conf. d'Eau douce, p. 32. pl. ii. fig. 8.; Grev. Alg. Brit. p. 195.; Harv. in loc. cit. p. 149.

Hab. About Edinburgh: *Dr. Greville.* Vicinity of Cheshunt, not uncommon.

"This species is one of the most common, and is found in nearly all ditches, principally in the spring. It is loaded with little bouquets manifest to the unassisted sight, and which with the microscope seem to be formed of a common peduncle, subdivided into pedicels, each of which carries on its summit a spherical body, in every way resembling the grains of other ectosperms, but nearly half as small again. In the middle of this bouquet is the horn, which, without doubt, performs the function of a male flower, and which is here but a prolongation of the peduncle. The number of grains varies from five to seven, but commonly four are met with." — *Vaucher.*

It is this species which is most frequently infested with the curious parasite, *Cyclops lupula* of Müller, which occasions the growth on the filaments of such extraordinary-looking appendages, in the midst of which the parasite resides.

A second racemose species is described by Vaucher, but this has not as yet been found in England; it differs in several essential respects from *Vaucheria racemosa*. The grains, like those of *V. racemosa*, are all supported on a common peduncle furnished with pedicels; but they are much larger and of a different form, and each, moreover, is supplied with a distinct anther.

e. *Capsules in pairs, terminal.*

11. VAUCHERIA OVOIDEA *Vauch.*

Plate V. Fig. 3.

Char. Capsules *in terminal pairs, a recurved anther being placed between each pair.*

Ectosperma ovoidea Vauch. Hist. p. 30.; Spec. Plant. p. 1634.; Flor. Ang. p. 954.; Flor. Scot. p. 979.; Withering, iv. p. 129.; Roth. Flor. Germ. p. 1. No. 7.; Cat. Bot. i. p. 16., ii. p. 192.; *Conf. amphibia fibrillosa et spongiosa* Dill. Hist. Musc. p. 22. t. 4. fig. 17. B. and C. B. *ramis elongatis;* Grev. Alg. Brit. p. 194.; Harv. in Hook. Br. Flor. p. 320.; *Conf. amphibia* Dillw. t. 41.; *Conf. furcata* B. Fl. Ang. p. 592.; Withering, iv. p. 128.; *Ceramium cæspitosum* Roth. Flor. Germ. iii. pp. 1. 175.; Cat. Bot. i. p. 154. ii. p. 186.; *Conf. palustris filamentis brevioribus et crassioribus* Ray, Syn. p. 447.

"Amongst flowering plants we find several instances of striking varieties produced by the more or less watery situation in which individuals chance to grow; and perhaps no botanist would acknowledge the two most opposite varieties of *Myosotis scorpioides*, or *Lotus corniculatus*, to be the same species, without an opportunity of tracing them through their several gradations. The same may be said of the present plant, which has hitherto formed two species, and it is only after a careful examination that I have united them as one."

"On the edges of ditches, and in similar situations, it frequently occurs in masses so densely matted, as to hold water like a sponge, with its surface beset by erect branches, which give it a very bristly appearance. In this state it is well known to botanists as the *C. amphibia* of all modern authors. Its hue is a bright green, becoming ash-coloured with age. The root I have not been able to discover, and the entangled mode of its growth renders it impossible to ascertain the length of the filaments. These are repeatedly divided with distinct patent branches, which, as before mentioned, when the plant grows in shallow water, so that some of them are exposed to the air, send out patent ramuli of a stunted growth, from being out of their proper element, which by their erectness give the plant its bristly appearance; yet, at the same time, if whilst in this state the waters rise so as to overflow the plant, their length is gradually increased, and losing their erect position, they yield to the current, and become the *Ceramium cæspitosum* of Roth; and after having thus changed, if by the subsidence of the waters the surface is again exposed to the air, the filaments, of course disposed horizontally, give the plant a bristly appearance by again throwing out erect patent ramuli."— *Dillw.*

The above description of Mr. Dillwyn, is applicable, I suspect, not merely to *Vaucheria ovoidea*, but to, perhaps, nearly all the *Vaucheriæ* which dwell in shallow water. *V. ovoidea* delights, according to Vaucher, in the purest water, that of fountains for example; and it is certainly not so common as might be supposed to be, if it were the only species of the genus which assumed a cæspitose character; for out of the many hundred examples which I have examined, I have never yet been so fortunate as to procure the plant in seed. On the young, dense, and spongy tufts it is rare to find capsules of any kind.

M. Decaisne describes movements of the capsular body of this species altogether analogous to those of *V. clavata*, detailed in the Introduction.

f. *Capsules numerous, lateral, on separate peduncles.*

12. VAUCHERIA POLYSPERMA *Hass.*

Plate VI. Fig. 6.

Char. Frond *minute.* Capsules *separate, in the form of a bird's head, pedunculated, varying in number from three to five, but usually there are but three sporangia, not entirely filling the cavity of the seed-vessels or capsules.*

Hassall, in Annals of Nat. Hist. vol. xi. p. 429.

Hab. Vicinity of Cheshunt.

This species, which is by no means uncommon, may be distinguished from all others known to me by the fineness of its filaments, which are not half so large as those of our other British species, no less than by the form and arrangement of the seed vessels. These are slightly pedunculate, varying in number from three to five, but usually there are but three, the apices or beaks of which are neither turned towards or averted from each other, but are all directed one way. The resemblance which the capsules bear to a bird's head when viewed sideways is very remarkable, and this resemblance is rendered still more striking by the fact of the circular sporangium occupying only the central portion of each, and which therefore represents the eye of the bird.

It is remarkable to observe that in this *Vaucheria* there are no distinct horns or antheræ, the base of each vesicle before its complete formation appearing to represent the anther.

g. *Proper Capsules none, Antheræ none.*

13. VAUCHERIA CLAVATA *Vauch.*

Plate II.

Char. Frond *cæspitose, the extremities of the branches clavate.*

Ectosperma clavata Vauch. Hist. des Conf. d'Eau douce, p. 34. pl. iii. fig. 10.; *V. Ungeri*, M. G. Thuret, in Annales des Sciences Naturelles; Berk. Glean. Alg. t. 10.; Harvey, in Manual, p. 149.

So far from agreeing with M. G. Thuret as to the propriety of referring all other species of *Vaucheriæ* to this one, and constituting a single species of the whole under the name of *Vaucheria Ungeri*, I am of opinion that *V. clavata* itself ought not to be regarded as a distinct species, but merely as a condition of almost any one of the numerous well-defined species which have been described. I am led to entertain this opinion from having repeatedly observed that the club-shaped extremities are present, terminating many of the filaments of almost all the species which are now recorded, and the distinctness of which cannot for a single moment be doubted. True it is that very many specimens covered with capsules do not present the club-form dilatations of the filaments, and also that these latter are generally present when the former are altogether wanting. But these facts admit of a rational and interesting explanation, entirely consistent with the view here expressed. The specimens of *Vaucheriæ* furnished with capsules, and those having them not, but possessing the claviform filaments, are usually met with under very different circumstances, the one for the most part in still water, and the other in flowing, such as streams and cascades, that is, the one set of specimens are found in circumstances favourable for the developement of capsules and antheræ, and for permitting the mutual influence, which these organs are supposed to exert on each other, to take place; and the other kind, or second set, are encountered in localities most unfavourable for these purposes and ends, and in which in many cases it would be impossible for capsules to develope themselves, the filaments being constantly washed and pressed upon by the force and weight of the incumbent and flowing waters. This leads to a necessity on the part of Nature, who is so fertile in resources in times of difficulty and danger, to adopt some other mode of repro-

duction for plants so circumstanced, and thus effectually to guard against the extinction of the species — her great care. This she beautifully and securely effects by ordaining that the reproductive bodies should appear at the extremity of the filaments, that is, in a situation where they are least or but little exposed to the impetuosity of the stream or cascade which may roll over them.

Vaucher remarks of the species as follows: — "It is met with in the pure and running waters of fountains and rivulets, and it attaches itself to the wood and stones which there are found, and upon which it forms tufts of a bright green. It appears to be composed of tubes, which are more slender than in the other species, and present likewise a more lustrous appearance; it is soft and unctuous to the touch; its extremities, principally in winter, are for the most part terminated with oval and not articulated masses, of which mention is made above. Their powder expands itself easily, especially when one irritates them with a needle; I have vainly sought for the grains of the plant; I have never been able to see them, although the species is very common, and I have sought for them for two successive years."

So far back as 1826, some interesting remarks were made on this plant, or state of one, by M. Frank Unger, which may not be deemed uninteresting. They are taken from Charlesworth's "Magazine of Natural History."

"I found," says M. Frank Unger, "near Vienna in a ditch containing some clear water, derived from the recent melting of the snow, a *Conferva*, which, after cleansing from the clay which surrounded it, I deposited in a wine-glass and placed in a window, where I could observe without disturbing it. This was on the 5th of March, 1826. Two days afterwards I noticed the production of a crowd of new ramuli, several lines in height, and rising from the general mass like a fine green miniature sward. On the 9th, these filaments produced fructification in the form of a darker green globule at their summits, by which I knew my plant to be the *Conferva dilatata*, Cat. Bot. Roth., or the *Ectosperma clavata* of Vaucher.

"As I continued my observations, I happened to look at the surface of the water, and was not a little astonished to find it covered, especially towards the side of the vase, with minute globules, unequal both in colour and size. Many of them swam freely about here and there, moving at their option in one way or another, retiring and approaching one another, gliding round globules that were motionless, stopping, and again setting themselves in motion exactly like animated beings.

"Conjecturing the identity of the green globules that possessed motion with those that had none, I immediately began to examine whence these infusory animalcula derived their origin, and what relation they bore to the green globules and the fructification of the *Conferva*.

"The next day I perceived a great number of the globules aggregated around the bubbles of air, disengaged from the *Conferva* and floating at the surface. Some of them were of a dark-green colour, and either round or elongated; others more transparent, tumid, and with one or two appendages diverging from or at right angles with each other; these were evidently plants in a state of germination; other globules again were oval, very dark at one extremity, and almost transparent at the other; these swam about freely.

"Within the space of an hour I succeeded in tracing not only the diminution of vitality and death of the *Infusoria*, but also the subsequent developement of the *dead animals* into germinating plants, in such a manner as to establish the truth of the fact. But on the 12th of March, I had the pleasure of ascertaining distinctly the origin of these minute bodies. I undertook to observe without interruption one of the tubercles of fructification, which I have already mentioned as terminating the filaments, in order to discover what became of the green matter enclosed within it. I had observed it for the space of half an hour when the following changes became perceptible.

"The globule became gradually darker in its colour, and a little transparent at its extremity: in the middle it was evidently somewhat contracted, and had some traces of

spontaneous motion. I could scarcely believe my eyes when I perceived the contraction to become more decided, and a cavity to be formed at the base. The contraction at length divided the globule into two smaller globules, which moved spontaneously towards the summit. As the developement proceeded, the cavity and the uppermost globule became enlarged, while the inferior globule became diminished: the latter at length disappeared, and the remaining large globule escaped by a terminal orifice, ascending till it reached the surface of the water. The whole of this process occupied about thirty seconds; but from subsequent observations it may be stated generally to take up one minute."

M. Unger has, in his late work, verified the correctness of the above observations in all essential particulars, and has further proved that the motion of the spores is owing to their surface being covered with vibratile ciliary organs, until lately supposed to be characteristic of animal life. M. G. Thuret has also more recently published an excellent memoir on the formation and developement of the spores in *Vaucheria clavata*. See Introduction.

" From the Constancy that is observed in the Number Figure Place and Make of all the principal Parts; and from the Variety in the less. Man is always mending and altering his Works; but Nature observes the same Tenor, because her Works are so perfect that there is no place for Amendments; nothing that can be reprehended. The most sagacious Men in so many Ages have not been able to find any Flaw in these Divinely contrived and formed Machines, *no Blot or Error in this great Volume of the World, as if anything had been an imperfect Essay at the first* (to use the Bishop of Chester's Words:) Nothing that can be altered for the better; nothing but if it were altered would be marred." —*Ray's Wisdom of God.*

Fam. II. THOREÆ.

Char. Main filaments *solid, inarticulate, filiform, branched, beset with short byssoidal, simple, or sometimes ramose and articulated fibrillæ.* Reproduction, *according to Kützing, capsular, and springing from the fibrillæ.*

2. THOREA *Bory.*

Char. Same as those of the family.

Thorea Bory, in Annales du Muséum, xii. 126. t. 18. (excél. sp. fig. 34.) *Hydroph.* Voy. Dupern. t. 24. fig. 3. Agardh species, ii. 123. *Polycoma* Palis, in Journ. Bot. 108. p. 123.

"The *Thoreæ* appear to be related to the *Batrachosperms*, with which M. Decandolle has confounded the species discovered by M. Thore. They ought to follow them in a classification. Like them, they present filaments of two kinds, and they are, for the most part, slippery under the fingers when one touches them; but the filiform filaments with which the plant is clothed are neither fasciculated nor verticillate. Whatever may be the fructification of the *Thoreæ*, it can never be disposed like that of the *Batrachosperms*, which consists of naked buds aggregated and placed in the centre of the verticilli, or wholly formed by the branches.

"With the exception of the last species, which is a parasite of certain lichens, the *Thoreæ* are aquatic plants. They dwell in the coldest fountains, have an aspect which is peculiar, extreme flexibility, the property of uniting themselves into mucous masses at the sources of waters, adhere strongly to paper in drying, and take on the appearance of life when they are replunged into the liquid in which they have grown." —*Bory de St. Vincent.*

It might be supposed by some, from what has been said in reference to the affinities of *Thorea* with the *Batrachosperms*, that it would naturally find a place amongst that family, from which, however, it must be admitted, though bearing certain resemblances to it, to be considerably estranged by its solid and inarticulate filaments.

This genus was constituted by Bory, in honour of Dr. Thore, "Naturaliste de Dax, auteur d'une Chloris du departement des Landes," by whom one of the species of the genus was discovered.

1. THOREA RAMOSISSIMA.

Plate XVI. Figs. 3, 4.

Char. Filaments *very long and much branched.* Colours, *when recent, blackish green, turning to violet in drying.*

Bory, in Annales du Muséum, vol. xii. page 128. pl. 18. fig. 1. *Conf. hispida ramis vagis flexuosis longissimis obductis ramulis setaceis*, Drap. ined. *Conferva hispida* Thore, Mag. Encyc. t. vi. p. 398. *Conferva hispida* Thore, Chloris, 442. *Conferva flexuosa filamentis cylindraceis villosis subgelatinosis; β. aquæ angustæ, filamentis ramosis, violaceo subfuscis; γ. pannensis, filamentis ramosissimis, violaceo griseis*, Bory, l. c. t. ii. p. 366. *Batrachospermum hispidum* Cand. Syn. 12.; Flor. Franc. ii. p. 60. *Th. Lehmanni* Lyngb. t. 13.; Harvey in Manual, page 120.

"The *Thorea ramosissima* grows in the Adour, where it adheres to stones, to rocks, to branches, and to the stems of trees which are found upon its margins. It is only to be obtained there when the waters are low, in June and July. It is again met with in the Seine, between Neuilly and Paris, attached to different bodies, and particularly to the bottom of boats.

"From a little disc fixed upon the inundated bodies, proceed certain filaments of the size of an ordinary thread, which from their origin are ramified. The branches are always

shorter than the filaments which give origin to them. The first are always simple, the latter are covered with new shoots, still shorter, up to near the extremities, these are usually simple, so that the last branches are constantly naked.

"The whole plant is covered with a fine and mucous down, about half a line long or more. This down gives to the branches the appearance of little cylindrical stalks of the size of a crow-quill. It is composed of simple" (rarely branched) "threads in the form of cilia, in which the joints are not apparent with a simple magnifying glass, but in which they are distinguished when they are submitted to a very strong lens.

"The branches of *Thorea ramosissima* are often many feet in length, and float gently in the water, whose course they follow. Their colour is an obscure and deep green. They assume very frequently on paper a very elegant scarlet tint. When they are macerated in pure water, they soon acquire the same tint, and they communicate it to every thing which surrounds them. Pieces of flax, cotton, and silk contained in the same vessels become dyed in a manner often very intense. This circumstance has made me presume that some use in the arts might be made for the fecula of *Thorea ramosissima*."

After detailing numerous chemical experiments, M. Bory de St. Vincent concludes his description of the species with the following remarks:—"As to the use which might be made of the fecula, that is easy; painters have found its tint more soft and more brilliant than that of violets obtained by other processes; but I doubt whether this beautiful colour would be very durable, by reason of the action which oxygen necessarily exercises upon it, as one of the experiments we have related shows."

The capsules, as seen in fig. 4. of plate XVI., which figure is taken from Kützing's "Phycologia Generalis," would appear to bear a close resemblance to those of *Trentepohlia pulchella*, being, as in that species, small, pyriform, corymbose, and subinvolucrate; the secondary branches are occasionally,

though rarely, again branched: this is also seen in Kützing's figure.

Mr. Harvey, in his "Manual," writes, "Of this beautiful plant, I have seen no British specimens. I introduce it on the authority of a note in the late Mr. Templeton's MS., whose well-known accuracy leaves no room to doubt his correctness in this instance, though he has not preserved a specimen in his 'Herbarium.'"

"It may be (for ought I know, and as some Divines have thought) part of our Business and Employment in Eternity, to contemplate the Works of God, and give him the Glory of his Wisdom, Power and Goodness, manifested in the Creation of them. I am sure it is part of the Business of a Sabbath day, and the Sabbath is a Type of that Eternal Rest; for the Sabbath seems to have been first instituted for a Commemoration of the Works of the Creation from which God is said to have rested upon the Seventh Day. It is not likely that Eternal life shall be a torpid and unactive State, or that it shall consist only in an uninterrupted and endless Act of Love; the other Faculties shall be employed as well as the Will in Actions suitable to, and perfective of their Nature; especially the Understanding, the Supreme Faculty of the Soul, which chiefly differenceth us from brute Beasts, and makes us capable of Virtue and Vice of Rewards and Punishments, shall be busied and employed in contemplating the Works of God and observing the Divine Art and Wisdom manifested in the Structure and Composition of them, and reflecting upon their Great Architect the Praise and Glory due to Him, then shall we clearly see to our great Satisfaction and Admiration the Ends and Uses of these Things which here are either too subtle for us to penetrate and discover, or remote and too inaccessible for us to come to a distinct View of." — *Ray.*

Fam. III. LEMANEÆ.

3. LEMANIA *Bory.*

Char. Frond *attached, coriaceous, ramose, and cellular.* Outer cells *small, polygonal, and firmly adherent;* interior *larger, more lax, sphærical, and empty.* Sporules *moniliform, fasciculate, naked, arising from the inner vesicles, and occupying the interior of the frond.*

Lemania Bory, in Annales du Muséum, vol. xii., also in Dict. class, ix. 274.; Agardh, in Act. Holm., 1814, t. 1. species 1, 2. *Nodularia* Link, in Schrad. Jour., 1809, p. 9.; Lyngb. t. 29. *Gongycladon* Link, in Hort. Physic. 6. *Trichogonus* Palis, in Jour. Bot., 1808, p. 123. (excel. sp.) *Vertebraria* Rouss, in Desv. Jour. Bot. i. 143. *Apona* Adans. 13. *Polyspermæ sp.* Vauch. t. 1. f. 3., t. 10. f. 1, 2. *Conf. sp.* Dillw. t. 29.; E. B. 1763.

The genus *Lemania,* like some other genera of freshwater *Algæ,* would appear to stand almost alone, exhibiting no very exact relation with any other division of this tribe, and the only plant to which it bears any definite resemblance appears to be the *Enteromorpha intestinalis,* and this only in its ramose habit, and in the cellular structure of the frond, the reproduction in *Lemania,* though simple, being wholly different from that of *Enteromorpha.*

Vaucher, in his description of his genus, *Polysperma,* of which *Conf. fluviatilis* formed the type, has not erred far from the truth, and his generic name might, with propriety, have been retained; the chief mistake which he committed, was in associating with *Conf. fluviatilis* the *Conferva glomerata,* a plant in every way dissimilar to the former.

The branches of the fronds of the *Lemaniæ,* in their young state, are cylindrical; soon, however, they are seen to become dilated at regular intervals. If one of these dilatations

be pressed between the fingers, their contents will be forced out: on examining which, with the microscope, the observer will be astonished to perceive that it is made up of a number of beaded and plant-like bodies, which the inquirer would be inclined, at first sight, to regard as the species in its young state: this opinion, on further investigation, would be found to be erroneous; for if these tufted bodies be watched, and kept in water for some time, the beads of the filaments will soon be perceived to separate from each other, and each ultimately to become developed into a young plant resembling that from which the seed was derived. The separation of the sporules which compose the beaded threads likewise takes place naturally within the frond, and it is by their developement that the dilatations of the stems, already referred to, are produced, and by which an apparent resemblance to the *Batrachosperms* is imparted to the plants of this genus.

Frequently, if these dilatations be examined with a lens, numerous filaments may be observed issuing from them: these are what Vaucher terms the young polysperms produced by the germination of the sporules, which are still within the frond, and which developement of them is ordained to take place in all cases to such an extent as to occasion the rupture of the dilatations, and consequent separation of some of the cortical cells from each other; thus, apertures are created, through which the sporules may pass out, a condition essential to the perpetuation of the species. The force with which this developement operates may be appreciated when the cartilaginous nature of the frond is considered.

It is only the middle and upper branches that are so torulose, the lower being almost plain and cylindrical; this arising from the fact of the sporules having all escaped from these, which are the oldest portions of the plant.

Bory's account of the structure of this genus appears to contain some strange errors. "The *Lemaniæ*," he remarks, "are articulated *Confervæ*, whose contiguous joints are united the one to the other by a solid interior filament, very well represented by Vaillant (Bot. Paris, pl. iv. fig. 5.) in

the figure which he has given of one of the species of our genus."

"The buds of the *Lemaniæ*, sessile, naked, rounded, more or less numerous, are situated at the points of junction of the cells, which by their growth they render tumid. When these gemmules come to cover or deform the plants they appear to detach themselves from them; they carry away sometimes the joints which support them and elongate themselves to reproduce new *Lemaniæ*."

The above observations certainly do not apply to the *Lemania* proper; but Bory has included in the genus one species at least (*Chara batrachosperma*, of which *Batrachospermum atrum* is a synonyme) which does not belong to it, and on this, distorted and irregular-looking bodies do occur, which I take to be analogous to the "glomerules" of other *Batrachosperms*; in this species as in others of the same genus the interior tube referred to by Bory would be found.

"The *Lemaniæ* are very rigid plants and with a peculiar and corneous appearance; they crack under the teeth with a taste which reminds one of that of fish."

"M. Thore of Dax first remarked, in the *Conferva fluviatilis* of Linnæus, a fact which is verified in the other species of our genus. The recent filaments of this *Lemania*, presented towards the flame of a candle, explode and extinguish the candle. This phenomenon does not take place in dried specimens. It is owing to some gas shut up in the connections of the joints, and which, put in expansion by the heat, presses against the walls and breaks them with an explosion. A remarkable movement of retraction is experienced in the fingers which hold by the two extremities the filament experimented upon. As to the smell of the burnt plant, although very peculiar, it cannot be compared to that of animal substances submitted to the fire."

"I have not met with any *Lemania* in stagnant waters; they grow in quick waters. It is in the pure fountains, large rivers, in very rapid rivulets, that they appear to delight. Many, moreover, flourish especially in those places

where the current has the greatest force, such as in mill sluices and the most impetuous falls of cascades.

"We have named our new genus *Lemania*. This name comes from that of M. Léman, a modest naturalist, not less learned in botany than in the other branches of science." — *Bory.*

Kützing, in his "Phycologia Generalis," appears to have studied this genus closely; he there gives a beautiful, elaborate, and accurate drawing of *Lemania torulosa*, from which the figure of that species given in this work is chiefly derived.

1. LEMANIA TORULOSA *Ag.*

Plate VII.

Char. Frond *nearly simple, incurved.* Inflations *of the* stem *large, approximate.*

Lemania incurvata, filamentis simplicibus, incurvatis, articulis in centro turgidis, Bory, Annales du Musée, vol. xii. p. 181. pl. xxi. fig. 1. *Chantransia* (*torulosa*) *virescente-nigrescens, filamentis subsimplicibus, articulis ovatis, medio tumidis,* Cand. Syn. 10. *Chantransie en colliers,* Cand. Flor. fr. 2. p. 50. *Conferva* (*torulosa*) *filamentis filiformibus, torulosis; geniculis contractis, annularibus; articulis ovalibus, inflatis;* Roth. Cat. Bot. 1. 200.; Fl. German. iii. 527. *Conferva* (*torulosa*) *filis torulosis, simplicibus, continuis, filiformibus,* &c., Roth. Cat. Bot. iii. 250. *Conferva* (*verrucosa*) *anomalacea, incurva, nodis eminentibus, approximatis, verrucosis,* Draparn. MS. ined. *Conferva* (*fluviatilis*) *filamentis simplicibus, setiformibus; geniculis crassioribus, angulatis,* Syst. Nat. xiii. 11. 1392. *Conferva fluviatilis var. a,* Encyc. Met. Dic. No. 12. (The synonyme of Vaillant ought to be excluded as also that in the "Flore Française." — *Bory.*) *Conferva nodosa var. a,* Lam. Flor. fr. 1278. ix. *Conferva fluviatilis nodosa, fucum emulans,* Dill. Musc. fig. 48. t. vii. *Lemania torulosa,* Ag. Spec. ii. p. 6. *Conferva fluviatilis var. torulosa,* English Botany, t.

1763.; Hook. Brit. Flora, ii. p. 322.; Harvey, in Manual, p. 119.

Hab. Mountain streams near Ludlow: *Dillenius.* Anglesea: *Rev. H. Davies.*

" It is now more than ten years since I observed, for the first time, this species, and I have named it after the very peculiar form and remarkable curvature of its filaments, *Lemania incurvata.* I believe that so very characteristic a name ought to be maintained; that which other botanists have since given to this plant applies equally to two orders of *Confervæ.*

" The *Lemania incurvata* abounds in certain rivers; I have above all observed it in the Dordogne, near the little town of Sainte Foix. The fishermen bring it up from the bottom of the river in their large nets. It has been confounded with the following species, even by Linnæus himself; the figures 47 and 48, given by Dillenius, and that of Vaillant, referred to alike indifferently by their authors, prove this.

" From a little horny disc, fixed to the hard bodies which support it, arise from six to thirty filaments, from one inch to two inches and a half in length, curved in one direction, perhaps by the continual action of the current, to which their rigidity opposes itself in vain. Their colour is of a brownish or reddish green, obscure or livid. They acquire in diameter the greatest dimensions of all the *Confervæ.*

" The joints are ovoid and thinned (*amincies*) at their point of contact, while, in the following species, the contrary is always observed. The *Lemania incurvata* is moreover shorter and thicker, and the filaments but rarely branched."—*Bory.*

2. LEMANIA FLUVIATILIS *Ag.*

Char. Frond *ramose.* Inflations *subdistant, oblong.*

Lemania (*corallina*) *filamentis subsimplicibus, articulis oblongis, extremitatibus turgidis,* vol. xii. pl. xxi. fig. 2.; Bory, in Annales du Musée. *Chantransia* (*fluviatilis*) *viridi-nigrescens; filamentis subdivisis, cartilagineis; articulis teretibus, geniculis tumidis,* Cand. Syn. 10. *Chantransie*

fluviatile Cand. Flor. fr. 2. 59. *Polysperma fluviatilis* Vauch. Conf. p. 99. Pl. 1. fig. 3. et pl. x. fig. 1, 2, 3. *Conferva (fluviatilis) filis subramosis, setaceis, nodosis, geniculatis ; geniculis torulosis, angulatis, &c.*, Roth. Cat. Bot. iii. 304. *Conferva fluviatilis filamentis setaceis, nodosis ; geniculis elevatis, brevibus, articulis oblongis, cylindraceis*, Roth. Cat. Bot. i. 201.; Fl. German. iii. 528. *Conferva fluviatilis var. β*, Encyc. Met. Dic. No. 12.; Thore, Chloris, 441. *Conferve rameuse var. β*, Lam. Flor. fo. 1278. ix. *Conferva (fluviatilis) filis simplicibus, setiformibus, rectis, geniculis crassioribus, angulatis*, Lin. Sp. 1635. *Conferva fluviatilis, lubrica, setosa, equiseti facie*, Dill. Musc. viii. f. 47. *Corallina fluviatilis non ramosa*, Vaill. Paris, p. 40. t. iv. fig. 5. *Nodularia fluviatilis* Lyng. t. 29. *Lemania fluviatilis* Kützing, Phycologia Generalis, p. 322.; Dillw. Brit. Conf. Pl.; Hooker, Brit. Flor. ii. p. 322. *Conf. fluviatilis*, English Botany, t. 1766. *Lemania fluviatilis* Harvey, in Manual, p. 119.

Hab. In the Winterbourne Stream, Lewes: *W. Borrer, Esq.* In the stream at Hamsell, and at the Waterfall at Harrison's Rocks in abundance: *Mr. Jenner.* Common in rapid streams about Aberdeen: *Dr. Dickie.* Frequent in Ireland: *Mr. Moore.*

" The name of *fluviatilis*, adopted after Dillenius by authors, does not well apply to a plant much less frequent in rivers than any one of its congeners. The name, borrowed from Sebastian Vaillant, better designates our *Lemania*, and gives a very just idea of its bearing.

" The *Lemania corallina* is one of the most common of *Confervæ ;* it is frequently found attached to stones, and upon stakes that are always covered with water, near mill-dams, or against the sides of their channels. I have seen falls which were quite covered; the more rapid the current the more the *Lemania* prospered. It becomes sometimes more than half a foot in length, and of a considerable diameter. The plant languishes or dies when any circumstance renders the water in which it has grown stagnant.

"From a cartilaginous disc, strongly applied to foreign bodies, proceed a great number of close filaments, elastic, of a brownish green colour, and a little curved at the base; but they become more pale and straight in the remainder of their length. These filaments are ordinarily from four to seven inches in length. Some are entirely simple, the others throw out here and there branches, or divide towards the middle of their length.

"The internodes are oblong, from a line to a line and a half, cylindrical, and inflated at their points of contact. Their divisions are often but little apparent, and disappear towards the base of the filaments, which appear continuous, cylindrical, and equal in diameter to a strong horse-hair.

"The surface of the filaments in old age is encrusted in such a manner as not to become recognisable either by its colour which changes, or by the destruction of the internodes, which become confused and disappear." — *Bory.*

"I have seen this species growing near the mouth of the Don, very luxuriantly, where it must have been exposed to the action of salt or very brackish water." — *Dr. Dickie* in lit.

"Let us then consider the Works of God, and observe the Operations of his Hands; Let us take notice of, and admire his infinite Wisdom and Goodness in the Formation of them: No Creature in this sublunary World is capable of so doing, besides Man, and yet we are deficient herein: We content ourselves with the Knowledge of the Tongues, or a little Skill in Philology, or History perhaps, and Antiquity, and neglect that which to me seems more material, I mean, Natural History and the Works of the Creation: I do not discommend or derogate from those other Studies: I should betray mine own Ignorance and Weakness should I do so; I only wish they might not altogether justle out, and exclude this. I wish that this might be brought in fashion among us; I wish Men would be so equal and civil, as not to disparage, deride and vilifie those Studies which themselves skill not of, or are not conversant in; no Knowledge can be more pleasant than this, none that doth so satisfie and feed the Soul; in comparison whereto that of Words and Phrases seem to me insipid and jejune." — *Ray.*

Fam. IV. CALLITHAMNEÆ.

4. TRENTEPHOLIA *Ag.*

Char. Frond *affixed, ramose, articulated.* Cells *in single series.* Fructification *corymbose, involucrate, and capsular.*

"Except for its freshwater habitat this genus does not differ from the preceding section of *Callithamnion*, which in the 'Brit. Flora' I ventured to unite to it. At Mrs. Griffith's instance I now give up this point, but must still observe that *Cal. Daviesii* and *T. pulchella*, when the latter is well-coloured, are scarcely distinguishable under the microscope." — *Harvey.*

1. Trentepohlia pulchella *Ag.*

Plate VIII. Fig. 2.

Char. Frond *parasitic, tufted, blood-red, much branched.* Filaments *equal, apices obtuse.* Articulations *four times as long as broad.* Capsules *pedunculate, in clusters, and ovoid.*

C. chalybea Roth, Cat. Bôt. iii. p. 286. tab. 8. fig. 2. *C. chalybea* Dillw. Brit. Conf. t. 91. *Conf. corymbifera*, E. B. t. 1996. and t. 2585.; Harvey in Hooker's Brit. Flora, p. 382.; Harvey in Manual, p. 118.

Hab. On flints in Winterbourne Stream at Lewes, Sussex: *W. Borrer, Esq.* On sandstones in a spring at Ladsworth, near Midhurst, Sussex: *Mr. Jenner.* Clonmel: *Dr. Allman.* Hill of Fare, Aberdeenshire: *Dr. Dickie.* Frequent in streams in Ireland: *Mr. Moore.*

"Professor Mertens first discovered the present delicate species in the neighbourhood of Bremen, and communicated it to Dr. Roth, who has published it with a good figure in the third volume of his 'Catalecta Botanica.' Mr. Borrer

has since added it to the British flora, having found it at Winterbourne Stream at Lewes, Sussex; and to him and Mr. Turner I am indebted for the specimen here figured. It grows on flint stones in little tufts about a quarter of an inch in length, and of a bluish green colour, glossy when dry. The filaments, which are repeatedly branched, are erect, straight, of equal height, and very flaccid and slender throughout. The branches are placed at uncertain, generally considerable distances, from each other, and issue from the stem so as to produce an obtuse angle, but immediately curve inwards, and then rise in a more or less upright direction; their disposition is far from regular, but they are frequently disposed on opposite sides in alternate parcels of two or three. The ramuli are always placed nearer to each other than the main branches, and I have frequently observed more than one proceeding from the top of the same joint; they are blunt at their apices; the dissepiments are readily observable with a microscope, and divide the filaments into perfectly cylindrical joints, of which the length is generally from four to six times greater than the diameter." — *Dillw.*

To the above very accurate description of a most beautiful production, it is necessary to add but very few words. The single species of the genus *Trentepohlia*, like those of the two preceding genera, seem to find pleasure in pure and running waters, attaching itself to any substance favourably placed in the current of the stream, and to which it can firmly adhere. When in health the plant is of a blood-red colour, a colour which, in decomposition, it readily imparts to whatever it may be in contact with. This colour, however, is observed to change either by age or habitat, or some other circumstance connected with its place of growth, to a bluish grey, in which state it constitutes the *Conferva chalybea* of Dr. Roth and Mr. Dillwyn. No difference can be detected between the filaments of the two states, which may therefore be concluded to be merely conditions of the same *Alga*. The fructification, which adds much to the beauty and elegance of the plant, is by no means rare.

Fam. V. CHARACEÆ.

Char. Stem *dichotomous and jointed; each joint composed either as in Nitella of a single cell or tube, or as in Chara of a single cell surrounded by other smaller contiguous cells, which take a spiral direction; each articulation moreover is surmounted by a variable number of branches three or four times jointed, which are arranged in the form of a verticillum or whorl, and at the joints of which the* reproductive organs *are situated: these are of two kinds, consisting of nucules and globules.* Circulation *spiral, and distinct in each cell.*

Following the example of those more recent Algologists who consider the *Characeæ* as *Algæ*, I give this order a prominent place amongst the British freshwater *Algæ*, a position to which they are well entitled, both on the ground of their greater comparative complexity of structure, and of the high interest attached to certain phenomena connected with their history.

The phenomena more particularly alluded to in the preceding paragraph are twofold; the first having reference to the circulation in the cells of which the different species of this order are composed, and the second to the existence of spermatozoa in the globules or male blossoms. These phenomena are confined amongst the freshwater division of the *Algæ* to the *Characeæ*.

In order that the nature of the circulation (which will first be considered), carried on in the cells of the *Characeæ*, may be more clearly understood, it will be advisable, previously to entering upon its consideration, to give a general notion of the structure of these curious productions.

The order *Characeæ* is divided into two genera, *Chara* and *Nitella*. The main stems of the different species of

Chara, which are all branched, consist of elongated cells placed end to end, and tapering in size from below upwards; surrounding these primary cells there are, in the perfect state of the plant, a number, in *Chara vulgaris* usually eighteen, of smaller secondary cells: these take a spiral course round the larger cell invariably from left to right. From the upper extremity of each cell grow out nine arms or smaller cells arranged in a campanulate manner; each of these arms have four or five joints, from which issue the organs of reproduction, to be described hereafter. From the superior extremity of many of the cells also grow out branches, and at the same time long and colourless branched articulated roots are sent forth. The genus *Nitella* differs only from *Chara* in the absence of the secondary spiral cells, and in the number of arms which go to form each verticillum or whorl.

The circulation in *Chara* was first noticed by Amici; in the two genera it does not differ materially, in both the course is spiral; the fluid, with its granules, passing obliquely and slowly from left to right up one side of the cell, turning round its extremity and descending in the same manner on the other side. A circulation of the same character prevails not only in the main cells of the stems and branches, but also in the secondary spiral cells or tubes, some of which are occasionally articulated or divided into other small cells, each, in like manner, having an independent circulation.

Mr. Slack (Transactions Soc. of Arts, &c., vol. xlix. p. 1.) long since observed, and the observation has been verified, that the ascending current of the circulating fluid is always in that half of each cell which is farthest from the axis of the plant; the descending, as a consequence, being confined to the opposite half, or that which is nearest the axis. The same observation Mr. Varley states to hold good in respect to the roots, due allowance being made for the difference in their direction, they, unlike the plant itself, taking a downward course.

A deviation from the above-described circulation has been noticed to occur in certain parts of *Chara vulgaris* by Mr.

Solly, and has been described by Mr. Varley in one of his excellent memoirs on *Chara* in the "Transactions of the Soc. of Arts," vol. xlix. p. ii. This deviation occurs in many of the cells which usually surround the seeds, and which are four in number when complete. It occurs, see plate LXI. fig. 1. of the present work, in those cells or sprouts surrounding the seeds marked *a, b, c, d, e, f, g, h,* in which the sap has taken a circular or cylindrical course round the axis. Mr. Varley thus minutely describes this deviation.

"Fig. 2. (pl. LXI.) is an enlarged view of the sprout *a*. The circulation is over to the right, as shown by arrows; it thus far agrees with the spiral course, which is always to the right. Near the point by the top arrow, there is such an accumulation as to form a ring or thick mass very like a diaphragm; this mass keeps revolving on its own axis. Near the second and third arrows the particles are more detached, each going round in its own circle; here the green studs, instead of being arranged in a straight line, are slightly curved. Still lower down, near the middle of the sprout, there is an inclined elliptical circulation, shown by dots and arrows; and from the bottom, particles are seen rising nearly as high as the oval, and descending again without appearing to follow any regular course: these are shown by dots and arrows.

"Some of the particles in sprout (*a*) were of sufficient size to be distinctly seen during the whole of their revolution, which took place in about fourteen or fifteen seconds: this observation was repeated by different persons, who nearly all agreed as to the time of the revolution; but in one of the sprouts I observed three particles differing in their speed, and occasionally passing each other. I counted their periods by my own pulse; one went round in nine beats, the next in eleven; these followed so nearly in the same track as to move aside whilst passing; the third sometimes occupied twenty beats, and at other times twenty-five in going round. They all appeared to keep to the circumference, and therefore the difference in their periods is more worthy of being remarked, as seeming to indicate that each particle had some cause of motion independent of the fluid in which it moved."

Various attempts have been made to determine the cause of the remarkable circulation in *Chara* and *Nitella*. The insufficiency for this purpose of the well-known laws of endosmosis and exosmosis has been ingeniously shown by Mr. Slack in a note inserted in the Second Part of vol. xlix. of the "Transactions of the Society of Arts," that lamented inquirer having ascertained that the circulation continued in all plants in which it has been observed when the portion was immersed in oil or mucilage, and in strong saline solutions, and even when not in contact with fluid of any sort, but surrounded only by the dry atmosphere.

In a letter addressed to the Royal Academy of Sciences, of Paris, in the sitting of November 23d, 1829, by M. Dutrochet, some highly interesting remarks occur relative to the circulation of *Chara*. The discovery was made very many years ago by Count Rumford, that water placed in vertical tubes circulates. In order that the circulation of so transparent a fluid may be the better appreciated it is requisite to suspend in it some molecular substance, the best for which purpose M. Dutrochet has found to be a few drops of milk, the specific gravity of which is nearly equal to that of the water. Many other substances will circulate in water, such as very fine sawdust, amber reduced to powder, and rasped cork; but these being of greater specific gravity than the element in which they are suspended, sooner or later subside to the bottom of the tube.

M. de Bailif illustrated, by means of an apparatus constructed on thic principle, the circulation which takes place in the cells of *Chara*, &c. M. Dutrochet, however, in the letter above cited, examines this curious physical phenomenon more closely. He found that the efficient cause of the circulation was caloric, that the rapidity of the motion depended on the amount of caloric to which the tube and its contents were subject, and that the direction of the current was governed by the same agent, the ascending stream being placed always on the side of the tube which received the most heat. M. Dutrochet observed, moreover, that light exerted a powerful influence on the circulation, which influence was attri-

butable to the caloric which accompanied its rays, and also that mineral substances in solution accelerated its speed. The caloric and the mineral substances in solution were supposed to exert this power by causing the greater separation of the molecules of the water, and thus increasing their mobility. Pressure was found to have a contrary influence, and to retard the circulation by, it was presumed, occasioning the closer approximation of the molecules, and so impeding their mobility. Viscid organic matter, such as gum, produced the same effect, and for a similar reason.

The causes not favourable to the sustenance of this physical circulation, therefore, are, the absence of caloric, or cold, and of light, upon which it follows that the motion ought not to take place during the night, pressure, and the solution of viscid substances in the liquid; all of which act in the same way, viz. by impeding the facility of motion between the aqueous molecules. On the contrary, the favourable causes are all those things which act in an opposite way, by increasing that facility.

A very curious fact is related by Dutrochet in reference to the circulation of aqueous fluid in tubes. It is this: that if a drop or two of acid, of alkaline solution, or a solution somewhat saline be added to the water contained in a tube, and which has had milk mixed with it, these substances, more weighty than water, precipitate themselves, and become dissolved. "This solution being achieved, the water is no longer susceptible of presenting the circulatory movement by means of simple diffused light; it only presents this movement at its superior part, and this only when the tube is exposed to the direct light of the sun, the continued action of which on the tube for many hours can scarcely penetrate the circulation to the depth of an inch in that water, whose molecules have acquired a very extraordinary *molecular fixity*. I consider this fixity as the result of a regular disposition of the molecules of the liquid. Indeed, when one agitates this liquid endowed with molecular fixity, it becomes immediately susceptible of circulation under the influence of the simple

diffused light. The agitation has changed, as it would appear, the regular order of the molecules of the liquid, and their aggregation has become confused. In this last state they enjoy a mobility of which they were deprived in their state of regular position; and it is to be remarked that water so changed with a mineral substance in solution and agitated, has more molecular mobility, and is more susceptible of circulation than was the pure water before this solution."

With the following extract, this epitome of Dutrochet's letter on the circulation of *Chara* may be concluded: —

"After having filled tubes with acidulated milky water I have closed them with the lamp. This liquid being fit for circulation, being unalterable, and not being able to lose any thing by evaporation, it follows that being exposed to the light it possesses the condition of a perpetual circulatory movement, with nocturnal intermissions, and further, with a winter intermission, which exists but when the temperature is inferior to 5° R. One might say, metaphorically, that this liquid is, during the night, in a state of sleep, and during the day, in a state of wakefulness; one might say also that its repose in winter is a state of hibernation. It might be supposed at first view that these phenomena bore some analogy to the state of sleep and of wakefulness of plants, and to their state of hibernation."

An experiment in reference to the circulation of the *Characeæ* may here be referred to, viz. that the application of a ligature to the centre of a cell does not destroy the circulation therein.

This experiment was originally made by Raspail.

A general description having now been given of the structure and circulation of *Chara* and *Nitella*, a few other particulars still remain to be noticed.

A delicate membrane lines the interior of each cell, having little or no attachment to the one which constitutes the proper cell membrane, and which is therefore easily separable therefrom, save at the lateral colourless longitudinal lines, which are formed probably by its attachment.

This membrane is studded over with a number of minute granules, which impart colour and texture to the plant. This inner membrane is represented in fig. 7. Concerning these granules, Mr. Varley makes some curious remarks: — "The minute green bodies always adhere to the membrane, and never to the outer tube. In some specimens these green bodies are so regular as to leave only a very narrow and even partition, whilst in others, the green studs are very scanty and irregular at the parting lines, appearing rather scattered about, as shewn in fig. 11. In such places, if the green bodies be patiently watched through a doublet 1-60th focus, they will be seen occasionally to expand and contract, change their form, move a little round, then more, and then go on to a whole turn or more; move forwards a little, and sometimes start off out of the field; some I have followed till they stopped behind stationary ones, and I have seen some come into the field and be stopped; also minute darkish dots are seen running along between these studs, and some of these would turn aside as by an eddy, and stop between them. Again, whilst writing this, I have seen some (where an open space had been made by bending or teasing the stem) move forwards, and then return; three or four separate ones came together laterally, then went forwards close to the regular and undisturbed ones; they then, after stopping some time, came back, and parted a considerable distance from each other, and with the motion of others, they were lost to any further observation, and the next day all the irregular ones had moved, and some parts assumed a more regular arrangement." The singular movements above described correspond precisely with those of the *Zoospores* described in the Introduction, to which, in other respects, one would not suppose them to be analogous.

Mr. Varley considers these green granules to be placed on the external surface of the inner membrane, to which, from their power of locomotion, they must be supposed to adhere but feebly. The purpose which they serve in such a situation, it is not easy to determine: were they adherent to the inner

surface of the membrane, their destination might be conjectured. The delicate and tender membrane itself might be regarded as the matrix for the developement of these granules, which, when mature quit it, and join the other granular bodies contained in the circulating fluid, and the nature of which is itself probably determined by their presence. That the granules studding the inner membrane do in some way or other enter the circulating fluid, is rendered highly probable by the fact that the majority of particles which it contains bear a close resemblance to these granules.

Mr. Varley further remarks in reference to these granules, that if any of them, situated in the middle part of a current, be disturbed by injury, no effect is produced, the stream passing on as before; but that if they be displaced over the boundary lines, a communication takes place between the two currents; a portion of the fluid near the boundary line, instead of passing on to the end of the cells, crosses over it into the returning current, and passes on with it, a portion of the descending, in like manner, joining the ascending and following its course. "I believe," says Mr. Varley, "that in this case the fine membrane is not wounded, but is probably loosened from its adhesion to the ridge, the green vesicles only being removed or injured: but it shows that there is a most intimate connexion between these vesicles and the circulation; and they appear to govern the circulation; for in the case above stated, where a clear space was refilled with green vesicles anastomosing had taken place; but when the spot was again coated with vesicles, the anastomosing also ceased, the fluid having again taken its direct course, coinciding correctly with the track marked out by their arrangement. I am led to think that any wound of the membrane would kill that whole cell, by submerging the vesicles in the thick or the inner fluid, and thus cutting off the continuity of their action, or by the different fluids mixing and so destroying their action. The fine membrane with the vesicles is seldom removed far enough from the tube to shew the colourless space between

(though I have samples before me now that shew it); therefore the fluid which passes between the vesicles must be very small in quantity, and is so limpid as to be difficult to discover."

In what way the removal or injury of the granules, placed, according to Mr. Varley, on the outer surface of the membrane can influence or govern the circulation carried on within that membrane, it is difficult to conceive. It seems to me, that the anastomosing of the currents can only be accounted for by adopting the view of Mr. Slack, relative to the internal organization of the *Characeæ* to be mentioned presently, or by supposing the internal membrane to be ruptured in the situation of the boundary line, thus permitting an escape of the circulating fluids from the interior of the membrane to its exterior, and so deranging the disposition of the granules.

Within the membrane which has been just described is the proper circulating fluid of the plant, which, in full motion, is dense and thick, though transparent, containing a variable number of solid granules, which circulate with it in the course already indicated from left to right. The granules do not, however, all move with equal velocity, or in a procession as it were.

Internal to this fluid, and occupying the centre or axis of the cell is another fluid, almost quiescent, and usually free from solid admixture. This is generally greater in quantity than the former or circulating fluid.

"These two fluids being of different densities," according to Mr. Varley, "do not when the plant is in health mingle, and are not separated by a membrane. According to Mr. Slack, however, a membrane does exist between the different fluids, enveloping the central, and forming an axis for the circulating fluid to revolve on, usually becoming attached in the course of the longitudinal boundary lines, thus separating the two currents of the circulating fluid from each other. It can now be understood in what way injury to this membrane, if it really exist, would occasion the

intermingling and anastomosing of the currents described by Mr. Varley."

This membrane, which must be of exceeding tenuity, is, however, in unhealthy states of the plant no doubt wanting. In certain states of *Chara*, several large spherical masses are noticed in the central fluid: these are supposed to consist of portions of the innermost dense circulating fluid which have become detached; and it is by means of these that the absence of the membrane can be demonstrated. The thick circulating fluid does not seem to be visibly affected by gravity, for it follows its usual course in whatever position the cell may be placed: the spherical bodies, which are described by both Mr. Varley and Mr. Slack, are, however, sensibly affected by gravity: if the cell be placed horizontally and one of these bodies be in the superior current, it will descend, slackening its speed as it enters the middle fluid, revolving as it passes through it, and returning by the lower currents: then again, if the plant be reversed, the same globules will again descend, and enter the former stream. The passage of globules from current to current through the central fluid proves that there is now no membrane surrounding it, and also that the central fluid is lighter than the circulating. Fig. 11. represents a cell containing several of these balls or globules.

For the purpose of tracing and following the course of these globules an apparatus, similar to Mr. Varley's vial microscope, is necessary. Having now completed the consideration of the circulation in the *Characeæ*, it remains to treat of the reproduction of the order — a subject always of the highest interest in productions belonging to the fresh-water division of the *Algæ*.

We will first describe the organs as they occur in *Chara vulgaris*, and which will serve as the type of the whole order.

The branches which compose each whorl in *Chara vulgaris* are usually nine in number, and consist of four or five cells, the lower ones of which are surrounded by nine other smaller cells, which pursue, like those covering the cells of the stems, a spiral course. At the junction of the major cells with each other,

and which are surrounded by the nine smaller spiral cells, and or are placed the organs of reproduction: these are of two kinds, nucules and globules, which have been denominated male and female; the upper being regarded as the female and the lower as the male apparatus. The female apparatus or nucule consists of a seed-vessel, which is composed of a membranous and brittle envelope, around which are wrapped five spiral cells, surmounted or crowned by five smaller cells. The cells, it is remarkable, pass from right to left, that is, in a direction the reverse of the cells on the stems and branches, and contrary also to the course of the circulation. (See pl. LXI. fig. 4.) In all these cells circulation is carried on. The brittle envelope referred to may not be a real organized membrane. Each seed-vessel, according to the observations of Mr. Varley and others, contains but a single nucleus or germ, which has a proper envelope: when young, it is of a green colour, the tubes being colourless: as it ripens it becomes darker, and then begins to fade away, and ultimately separates and disappears. The seed or nucleus is then ripe, and ready to separate, connected only by the brittle envelope, which is entirely soluble in acids. When this is removed the nucleus or kernel appears with its dark and shining skin, "which is flexible and tough enough to bear squeezing out of shape." On the rupture of this the contents issue forth, which are compared to wheat flour by Mr. Varley. Such is a brief outline of the seed and seed-vessels: the structure of the male blossom, if it may be so termed, is more complicated. It is spherical and situated beneath the seed-vessel, surrounded by its four sprouts or cells. (See pl. LXI. fig. 4.) Although these globules, as well as the seed-vessel or nucleus, are placed at the juncture of the principal cells with each other, they do not arise directly from these, but rest on a number of smaller cells, which are there found, and which, as some of them present phenomena, which are peculiar, and which are accurately described by Varley in vol. iv. part 1., it will be well to notice before following up the anatomy of the globule. The cells which present these peculiar phenomena are, first, that upon which rests the stalk of the globule; secondly, that which sup-

ports the stalk of the seed-vessel; and thirdly and fourthly, two other cells, which lie on each side of the cell, supporting the stalk of the globule. "In ordinary tubes or cells," Mr. Varley writes, "there are green vesicles regularly arranged on the thin membrane which lines them, and the circulating fluid appears thickened by innumerable particles, a little denser, or not quite fluid, and with scarcely any colour. But in these peculiar cells there are generally very few stationary green vesicles, except about the angles formed by the adhesion of other cells. The fluid within is very clear and limpid, with many very equally sized green granules floating in it. Those that are still, and those that are moving, appear to be the same; and some are seen to stop, and some stationary ones are seen to break loose and go on: they are rather larger than the orderly arranged green vesicles of other cells; but being loose, and the cells so glossy, they are seen very bright and distinct. This is not all; for they circulate round the cells very quickly and freely, undergoing some extraordinary influence; for they knock against one another, appear to stick at some places, or as if they squeezed by, and then rush on quicker: many, as they come near particular parts of the cells, spin round most rapidly as they go on, different particles turning in opposite directions; and others only catch a slight impulse to spin, suddenly turning round and back again, and go on without spinning; others, near the centre of rotation, go round together, then start into a quick whirl, then vary or slacken, and again start into a furious whirl, showing considerable fluctuations in their motion; and in the larger rounds they appear to receive some impulse whenever they touch that part of the surface which joins the arm, as though they were slightly electrified." These motions precisely resemble those of the zoospores, and are doubtless voluntary, performed, as in their case, by means of vibratile organs or cilia.

We will now describe the globule itself: this, as has already been observed, is spherical, with a light red nucleus, the coating being made up of about eight deeply indented triangular segments. (See plate LXI. fig. 4.) These con-

tain a number of small red granules, to which the colour of the globule is principally owing. Within these segments are noticed, first, the stalk of the globule, which is pyriform, and rests upon one of the peculiar cells which have been described. Upon the summit of this stalk rests a number of smaller spherical or pyriform cells: these occupy the centre of the globule, and from them proceed a number of large cells to be inserted into the segments which form the coating of the membrane, and by means of which their segments are retained in their proper situation. These last cells correspond in number with the segments, one going to each. Lastly, interwoven together, and filling the interstices between the cells, are numerous fine articulated threads, to be more particularly referred to hereafter.

Now in the footstalks of the nucules and those of the globules, as well as in the radiating cells attached to the segments, a peculiar body or vesicle is noticed. This was first, I believe, discovered by Mr. Varley, but has since been noticed and described by other observers; although its office has not yet been determined. This vesicle is situated in the circulating fluid of the cells, the course of which it follows, although from its size it frequently projects some distance into the central fluid.

In the stalk of the globule, and in those of the segments, in addition to the transparent vesicle, there are membranes studded with vesicles similar to those of the external and ordinary cells, and in like manner arranged so as to show the ascending and descending currents; but instead of being green, as in the former case, they are bright red.

We now come to relate the most extraordinary circumstance, not without parallel, however, in the vegetable kingdom, connected with the history of these most interesting productions. The spaces between the stalks of the segments, it has been remarked, are filled up with entangled filaments or vessels which appear ringed. The contents of each division between the rings first appear angular, and subsequently resemble a thread coiled up; "after a while," to adopt the language of the first discoverer of the fact, "these

coils (see pl. LXII. fig. 3.) within the divisions become agitated; some shake or vibrate about, others revolve in their confined places, and many come out, thus showing that they are spirals of two or three coils, and then with an agitated motion swim about. Now the field of view appears filled with life; great numbers of these spirals are seen agitated and moving in all directions; they all have a directive force, one end always going foremost and never the other; many stray a great way out of the field; these, by getting clear of each other, are best to observe; they do not quite keep their form as a stiff spiral, but their foremost end seems to lash about; and to many are seen attached (see plate LXII. figs. 5, 6.) almost invisible but very long fibres. These fibres were in quick undulations, which rose in waves from the spiral to their farthest end. It appears that these fibres cause many of the spirals to entangle together, and thus bring them to a state of rest; therefore the separate ones were best to observe."

With a few other remarks this brief description of the *Characeæ* may be terminated. The spiral disposition of organs seems to prevail almost universally throughout the works of nature. The most superficial observer could not be at a loss for a single moment to point out examples of it. In the zoophytes this arrangement of parts is especially obvious; in no order of productions is it, however, more apparent than in that which is under discussion. The tubes which enfold the main cells are spirally disposed; the circulation in these cells follows a spiral course; and lastly, the cells of the seed-vessel are exactly, simply, and beautifully spiral; exactitude, simplicity, and beauty being the chief characteristics of the spiral disposition or formation.

The preceding pages embody an accurate and minute description of the different parts constituting the structure of the order *Characeæ*, and of the different remarkable phenomena presented in those parts; so accurate, indeed, as to leave but little to be desired in this respect: and yet, how much remains to be solved and explained! how deep is the mystery which veils the right understanding of the different actions which have been detailed! The following questions may be pro-

posed, but who shall answer them? Is the globule really the male apparatus? and are the spiral coils which may be denominated animalcula the agents whereby the seeds are fertilized? and if so, in what way do they effect this grand and prime object? what also is the nature of those numerous particles contained in the peculiar cells whose motion seems only to be regulated by individual will, and what is the office over which the vesicles in the cells of the footstalks preside?

M. Bischoff (Die Cryptogamischen Gewächse, 1re livr., 1828) was the first to observe the animalcula of *Chara.* Using a microscope of but feeble power, however, he did not make out their origin. Afterwards Meyen gave very imperfect figures of them in the "Annales des Sciences Naturelles," t. x. p. 319. pl. 10. 1838. Mr. Varley, however, from whose excellent papers I have had occasion to draw so largely, appears to be the first observer, who gave an accurate, minute, and complete description of them in his paper in the "Trans. of Society of Arts," published in 1834; a paper, with the existence of which M. Gustave Thuret did not seem acquainted when he published his excellent memoir "Sur l'Anthère du Chara" in the 14th volume, second series, of the "Annales des Sciences Naturelles," 1840, as no allusion is made to it therein, and the facts detailed do not differ in any essential particular from those previously made known by Mr. C. Varley.

M. Peyen has examined the *Characeæ* chemically. The following are the more important of his remarks: —

"The orange-coloured vesicles (globules) which are seen on the branches of *Chara* contain, as is known, cellules very long and flexible. I have ascertained that their fine membranes have the chemical composition of vegetable tissue, while the substances enclosed by them present the azotized composition proper to bodies enveloped in the young organs of plants."

"These analytical results appear to me to be natural consequences of the constitution of the reproductive organs of *Chara,* such as M. Brongniart has indicated not only as to the monospermic grain, but also relatively to the azotized

substances contained in the vegetable membranes which are related to the pollen of the male organ."

"These chemical facts should be in harmony with the observations of M. Meyen and those of M. Brongniart upon the spontaneous movements of little bodies enclosed in the pollen. (Ann. des Sc. Nat., Nov. et Dec. 1838.) The particles of Brown are found in my experiments to have an azotized quaternary composition."

The monospermic grain is composed chiefly, as was first indicated by Raspail, of farina.

The affinities of the order *Characeæ* are by no means striking or satisfactorily determined. In being composed of tubular cells, and in the disposition of these they exhibit a relation to the Confervoid *Algæ* generally, in the arrangement of their branches in whorls, and in the circumstance of the primary being crusted with other secondary and descending cells, they manifest a relationship with the *Batrachosperms* in particular. In their organs of reproduction, and in certain other respects, they bear some resemblance to the *Equiseta*, I know not how exact however. The *Characeæ* are not the only order of freshwater *Algæ* possessing double organs of reproduction: as, for example, *Vaucheria*. Linnæus first referred the *Characeæ* to the *Cryptogamia*, but subsequently, regarding the globules as stamens and the nucules as pistils, he removed them to *Monœcia Monandria* amongst flowering plants.

The *Characeæ* are almost universally distributed: they are found abundantly both in fresh and stagnant waters, in all parts of the world. They form an important link in the economy of Nature, in life purifying by the liberation of oxygen during respiration, the impure and almost pestilential waters in which they are frequently and especially encountered, and in death yielding by their decomposition elements which impart fertility to the soil, and render it fit for the growth and nourishment of plants of an order higher in the scale of organization than themselves, and of more direct utility to man, the destined recipient of all Nature's bounties, and for whose benefit every natural contrivance directly tends. Let this thought impress

the heart with the conviction of the goodness of God towards man, who often ungratefully omits to remember it, and who therefore needs to be from time to time reminded of it. The important part which the *Characeæ* take in the formation of the earth's strata, geological investigation has made strikingly and beautifully manifest, their fossil remains having been found in great abundance in the freshwater strata covering the chalk formation in the Isle of Wight, and in the marls of Forfarshire, and other places — their remains consisting of portions of the stems, but principally of the nucules which Lamark mistook for the shells of testaceous animals, and acting under this impression named them *Gyrogonites*. The fossil remains found in the calcareous marls of Forfarshire have been identified as belonging to *Chara hispida*, the same species still existing in a living state in great profusion in the lakes which still cover portions of these marls.

The one grand purpose for which all cryptogamic vegetation would appear to have been created, is the formation of soil for the growth of productions more necessary to the wants of man. First, the lichen, stunted and dry, but rich in salts, appears on the face of the primordial rock. The rains of Heaven descend upon it and moisten it, causing the dissolution of a portion of the rock itself: this it quickly imbibes and retains in a more soluble form. It lives its allotted time, then dies, and decomposes, liberating what it had derived from the rock, together with the constituents of its own fabric. By the continued and successive growth of the lichens, however, a portion of the surface of the rock becomes hollowed out, and a pool of water rests therein. The lichens now finding this no longer a place fit for their developement, disappear. Ere long, however, the sporules of a moss or a conferva light upon this spot, and finding therein the circumstances requisite for their growth, grow and flourish there for a period. Each season they die also, and the quantity of their debris annually increases, so that at last the pool is filled up: next in order *Equiseta*, *Carices*, and *Juñci* appear, and finally a soil is collected, rich in the elements of fertility. The fungi assist much in the formation of soil; but in a very different manner,

They require for their growth highly nutritious substances, such as dead organic matter: this by their thalli, or thousand rootlets, they quickly disorganize, appropriating a small portion of it to their own nourishment, but allowing the return to earth, to be again appropriated in some other form of tissue, of by far the greater portion of those substances.

The *Charæ* are frequently called Stóneworts, from the quantity of calcareous matter with which they are often incrusted, or perhaps which they evolve, this property rendering them agents still more important in the formation of soil.

5. NITELLA *Ag.*

Char. Plant *more or less pellucid.* Cells *tubular, not invested with a secondary layer of smaller cells.* Globules *and* nucules *mostly on the terminal whorls, and axillary.*

Of this and the following genus no figures are proposed to be given, as their inclusion did not enter into the original intention of the work. This is the less to be regretted, as very good figures of the species are extant, especially those of "Eng. Bot."

1. NITELLA TRANSLUCENS *Ag.*

Char. Stem *elongated, flaccid, pellucid, glossy; branches of the whorls spreading, elongated.* Nucules *and* globules *approximate, on the smaller ramuli scarcely bracteated.*

Chara translucens, Eng. Bot. 1855, 2d ed. t. 1467, Hook. Crypt. Fl. part 1. p. 245.; Macreight, 278.; *Nitella translucens* Ag. Syst. Alg. 124.

This species grows in deep and stagnant ponds: it has been found in several localities, but is by no means common. It is the largest of our native species, and well adapted, from its transparency, for microscopic examination, of which it has often been made the subject. The whole plant is exceedingly smooth and glossy, whence its name. The distance of the whorls, and thickness and size of the branches, vary in different specimens. Fructification met with from July to September.

2. NITELLA FLEXILIS *Ag.*

Char. Stems *repeatedly dichotomous, one to two feet long, smooth, flaccid, somewhat glossy, and pellucid: borders of the whorls compound, obtuse.* Nucules *and* globules *approximate, few, scarcely bracteated.*

Chara flexilis, Eng. Bot. t. 1070.; Eng. Bot. (2d ed.) t. 1468., and fig. *c* to *l*, t. 1472.; Smith, 1. 7.; Hook. Crypt. Fl. part 1. p. 245.; Macreight, 278. *Nitella flexilis* Ag. Syst. 124.

"Not unfrequent in ditches, lakes, and still waters. A much weaker and more slender plant than the last, with the branches of the whorls generally, but not always forked, or divided into three or four segments, rarely all simple. Nucules often solitary. It is never so glossy and bright in its hue as *N. translucens*, and not uncommonly is found more or less incrusted with calcareous matter, rendering the stems somewhat opaque: in this latter state it is *N. opaca* of Agardh." — *Eng. Bot.*, 2d ed.

3. NITELLA NIDIFICA *Ag.*

Char. Stems *simple, below smooth, flaccid, somewhat glossy, and pellucid: primary whorled branches simple, elongated; fertile ones numerous, crowded, proliferous.* Nucules *and* globules *separate, bracteated.*

Chara nidifica, Eng. Bot. t. 1703., 2d ed. t. 1469.; Smith, 1. 8.; Hook. Crypt. Fl. part 1. p. 245.; Macreight, 278. *Nitella nidifica* Ag. Syst. 125.

"A native of saltwater ditches in the South and East of England. The simple much elongated branches of the primary whorls, and the crowded and proliferous character of the fertile ones, form the chief distinctions of the species, the globules and nucules not being always separate. I have found the globule stalked, but that occasionally occurs in *N. flexilis*, and it is not uniformly so in the present plant.

"It would be desirable to ascertain the effect of cultivation in perfectly fresh water upon this species, as specimens of a

Nitella, collected in the vicinity of Ely, seem to be intermediate between it and *N. translucens*. The suggestion thrown out by Sir W. J. Hooker that our native *Nitellæ* may be all varieties of a single species, as our *Charæ* are perhaps of a second, is far from improbable."—*E. B.* 2d edit.

4. NITELLA GRACILIS *Ag.*

Char. Stems *smooth, glossy, pellucid; branches of the whorls compound, their segments acute; the upper ones often all fertile.* Bracteas *wanting.*

Chara gracilis, Eng. Bot. t. 2140. 2d edit. 1470.; Smith, i. 9.; Hook. Crypt. Part 1. p. 245.; Macreight, 278. *Nitella gracilis* Ag. Syst. p. 125.

"Found in boggy pools in St. Leonard's Forest, Sussex: in Llyn Idmel, North Wales; and in Jersey. Pale green, shining, very transparent. Fructification axillary in the divisions of the branches of the upper whorls; generally one nucule and one globule, side by side, sometimes separate, and, according to Mr. Wilson, on different plants.

"A small, very delicate, and elegant species, but only doubtfully distinct from *N. flexilis*."—*E. B.* 2d edit.

6. CHARA.

Char. Plant *more or less opaque, very brittle; striated, often spirally.* Primary cells, *excepting the ultimate ones of the branches which are uncovered, invested by a layer of secondary smaller cells, which take a spiral course.* Globules *and* nucules *regularly dispersed along the whorled branches.*

1. CHARA VULGARIS.

Char. Stem *smooth, opaque, brittle, obscurely striated.* Primary cells *of the stems invested with about eighteen smaller spiral cells; those of the branches or whorls with about half that number.* Nucule *bracteated.* Bracts *usually four, much longer than the nucule.*

Chara vulgaris, E. B. 336. 2d edit. 1471; Smith, i. 6.; Hook. Crypt., Part 1. p. 246.; Macreight, 278.; Agardh, Syst. Alg. p. 128.

This is the commonest species of the whole genus: it is met with in ponds, ditches, and slow streams, and is usually of a yellowish green hue. The stems are sometimes seven or eight inches long. Whorls about as long as the articulations of the stem, the upper ones alone being fertile. This *Chara*, from its great abundance, has most frequently been the subject of microscopic observation, and amply has it rewarded the labours of investigators.

2. CHARA HEDWIGII.

Char. Stem *smooth, striated, opaque, somewhat brittle, elongated.* Branches *of the whorls subulate; fertile ones with many whorls of short ramuli or bracteæ, of which the longest are shorter than the fruit.* Nucule *ovate.*

Chara Hedwigii, E. B. Suppl. t. 2762. 2d edit. 1472, in part; Hook. Crypt., Part 1. p. 246.; Macreight, 278.

"Met with forming dense patches at the bottom of still pools in several parts of the kingdom. Stems much longer and more slender than in *C. vulgaris;* and the whole plant of a bright green colour, but sometimes partially incrusted; rather flexible when freshly gathered: each joint appears to be divided about the middle in consequence of the smaller tubes, forming the wall, being articulated midway as well as at the principal joints. Nucule much larger than its accompanying globule; about as long as, or rather longer than the three or four apparent bracteæ which accompany it." —*E. B.*

3. CHARA PULCHELLA.

Char. Stem *smooth, striated, flexible.* Branches *of the whorls subulate; the fertile ones with many whorls of short ramuli or bracteæ, the longest of which are about the length of the nucule.* Nucule *oblong.*

Chara pulchella, Eng. Bot. sup. 2824, 2d ed. 1473. Walroth Ann. Bot. 184. tab. 2. *C. pulchella globularis*, Wallr. Fl. Crypt. German. vol. 2. 108.

Found by Mr. Borrer in Sussex.

"Distinguished from *C. Hedwigii* principally by its more flexible stems and more oblong nucules. When dry, it is scarcely at all brittle, whereas *C. Hedwigii* is extremely so, whence it is called *C. fragilis* by some authors."

Perhaps merely a variety of *C. Hedwigii*.

4. CHARA ASPERA.

Char. Stem *very slender, scarcely brittle, obscurely striated beset with scattered, spreading, or deflexed bristles.* Branches *of the whorls subulate; the fertile ones with many whorls of short ramuli or bracteæ, the two innermost longer than the rest, bearing the* globules *or* nucules *which are generally separate.*

Chara aspera, Eng. Bot. Suppl. 2d ed. 1474; Hook. Crypt. Flor. Part 1. p. 246.; Macreight, 278.; Greville, Scot, Crypt. Flor. 339.; Agardh, Syst. Alg. 130.

"Found in bog pits, and still waters in several places in the north of England and Scotland. Stem one or two feet long, densely crowded, every where beset with acute, slender, straight, spreading or deflexed bristles; and having at the base of each whorl a row of appressed bristles, connected in pairs, of which one points upwards and the other downwards.

"Between the outer circle of tubes and central one, in both the stems and branches, is found a green parenchyma, arranged in lines alternating with the striæ, and separated or broken transversely at intervals, giving them a spotted appearance; globules and nucules solitary, often on separate plants.

"I have had this species under cultivation in a glass jar for several years, and although no nucules appeared at any time upon it, young plants were copiously produced every spring."

5. Chara hispida.

Char. Stem *more or less thickly covered with a calcareous crust, opaque, brittle, striated, spinulose, or hispid.* Branches *of the whorls subulate; the fertile ones with many whorls of short ramuli or bracteæ, of which three or four are larger than the* nucule *and* globule *that they accompany.*

Chara hispida, Eng. Bot. 463. 2d ed. 1475; Smith, i. 7.; Hook. Crypt. Part 1. p. 246.; Macreight, 278.; Ag. Syst. 128.

"Not uncommon in ditches, lakes, and turfy bog pools. The stony incrustation is sometimes so thick as to give the plant the appearance of a petrifaction, which in other habitats is nearly wanting. Almost as fœtid as *C. vulgaris*. It is by far the largest of the true *Charæ* in this country in its ordinary form; and, though varying in the thickness of its stem and branches, can never be confounded with the slender and more delicate *C. aspera*.

"A smaller variety is occasionally met with in which the spinules are obsolete, or nearly so: the *C. hispida* β′ of Agardh and Smith, β *gracilis* of Hooker, Eng. Bot."

6. Chara latifolia.

"This fine species, which I have no hesitation in stating to be new to Britain, occurred in great abundance in Belvidere Lake, county Westmeath, where I collected it in August last. The great size and semipellucid appearance at once struck me as remarkable. The main branches are striated and covered with raised rough points, as are the first joints of the whorled ramuli, while the remaining portion consists only of one pellucid tube, which is thicker than the lower joints, and ends in a sharp point. The branches of the whorls are again beset with smaller ramuli (not bracteæ), in which respect it differs from all our species in the opaque division. I regret I could not find the species in fruit, neither globule nor

nucule was present; though I examined hundreds of specimens in various parts of the lake, where it sometimes covered the bottom to the extent of many square perches; and what is singular enough, all the other species in the opaque division occurred abundantly in the same lake, and were all in fruit, each preserving its respective character." — *D. Moore, in "Journal of Botany,"* p. 43.

The application of the specific name *latifolia* seems to be peculiarly inappropriate to a plant which, strictly speaking, has no leaves at all.

"God is said to be *Maximus in minimis.* We Men esteem it a more difficult Matter, and of greater Art and Curiosity, to frame a small Watch than a large Clock: And no Man blames him who spent his whole Time in the Consideration of the Nature and Works of a Bee, or thinks his Subject was too narrow. Let us not then esteem anything contemptible, or inconsiderable, or below our notice taking; for this is to derogate from the Wisdom and Art of the Creator, and to confess ourselves unworthy of those Endowments of Knowledge and Understanding which he hath bestowed on us. Do we praise *Dædalus*, and *Archytas*, and *Hero*, and *Callicrates*, and *Albertus Magnus*, and many others which I might mention, for their Cunning in inventing, and Dexterity in framing and composing a few dead Engines, or Movements, and shall we not admire and magnifie the Great Δημιουργος Κοσμου, *Former of the World*, who hath made so many, yea, I may say, innumerable, rare Pieces, and those too not dead ones, such as cease presently to move so soon as the spring is down; but all living, and themselves performing their own Motions, and those so intricate and various, and requiring such a Multitude of Parts and subordinate Machines, that it is incomprehensible what Art, and Skill, and Industry, must be employed in the framing of one of them?" — *Ray.*

Fam. VI. BATRACHOSPERMEÆ.

Char. Algæ *gelatinous, moniliform, ramose, articulated, verticillate, filaments of the verticilli dense, dichotomous, and beaded, the inferior ones simple, descending, and forming a sheath around the primary cells.* Reproduction *consisting of glomerules scattered throughout the verticilli, to which they are attached by a single filament or thread.*

7. BATRACHOSPERMUM.

Char. *Same as those of the family.*

Derivation. From *βατραχος*, a frog, and *σπερμα*, seed; the species resembling frog-spawn.

Dillenius discriminated many species or varieties of this genus in his "Historia Muscorum," under the name of *Algæ lubrices.* Linnæus, however, after him, united them all into one species, under the name of *Conferva gelatinosa,* in which example he was followed by succeeding botanists.

Weiss first removed the *Conferva fontana, nodosa, spermatis ranarum instar, lubrica et viridis,* of Dillenius from the genus *Conferva,* perceiving that it possessed a structure much more complicated than that of the greater number of the species of that genus, which are for the most part exceedingly simple, and placed it amongst the *Characeæ,* under the name of *Chara batrachosperma;* the term *batrachosperma* implying the resemblance which Weiss noticed between the *Conferva* which he examined, and the series of gelatinous globules in which are enclosed the eggs of the greater part of the Amphibia of the family of frogs.

If it was requisite that this species should be removed from the genus *Conferva,* it soon became apparent that it could not be permitted to remain with the *Characeæ,* and the propriety of instituting a new genus for its reception quickly became apparent.

"In the year 3," says Bory, "I established this genus in my collection. I communicated it to my learned friend

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Draparnaud, and that skilful naturalist approved of it. Roth, and after him Vaucher and Decandolle, have adopted it, with the trivial name of Weiss, which has become general."

The *Batrachosperms* are highly flexible and mucous to the touch, their lubricity arising in a measure from the presence of innumerable lashes or cilia, terminating the branches, which add also infinitely to the microscopic beauty of these productions. Vaucher entertained the idea that they were to be regarded as the stamina of the plant, and that they were filled with a fecundating powder. This opinion would appear to be mere conjecture, the only fact in support of it being the deciduous character of the organs. Each cilium is articulated in a manner similar to that of the branches, of which they may be regarded as extensions.

The species of this genus inhabit mostly pure and running waters, being usually met with in fountains, wells, and streams, the force of which is not considerable. They are so exceedingly flexible, that they obey the slightest motion of the fluid which surrounds them, and would seem almost to be endowed with vitality; nothing can surpass the ease and grace of their movements. When removed from the water they lose all form, and appear like pieces of jelly, without trace of organization, on immersion however the branches again quickly resume their former disposition. They adhere strongly to paper, and in drying frequently change to some other tint, usually much deeper; on being moistened after long intervals, they recover much of their original freshness; and it is even asserted that, after having lain in the herbarium for some years, when they are replaced in water in a suitable locality, that they will vegetate as before.

The manner in which the glomerules are developed does not seem to be well understood*; each would appear to be compounded of numerous cells, all having a single and common attachment to the parent plant by means of a single and slender thread; from which they, when mature, separate,

* In the earliest period of their development they would appear to be minute excrescences growing out of the walls of the cells, from which finally they become entirely separated in most of the species of the genus, but not in all, as in *B. atrum*.

or are thrown off. They would appear to partake more of the nature of buds than seeds. When developing, each emits numerous branches, which radiate in all directions.

Bory would seem to be the only observer who has studied the species of this genus with that nice discrimination which they require: in associating *Batrachospermum atrum*, however, and some other species with the genus *Thorea*, he has committed a great error. By a careful comparison of specimens derived from the herbarium of Dillenius, which are in the collection of M. de Jussieu, with others collected by Roth, Mertens, and Draparnaud, Bory has succeeded in ascertaining the correct synonymes of several species or varieties, which had previously been quoted indiscriminately.

From the great number of specimens described in the following pages, there are some, I fear, who will be disposed to think that they have been multiplied on insufficient grounds: such an opinion I am sure will not be entertained by those who have carefully studied the genus for themselves, and who have had opportunities, as mainly through the liberality of friends I have had, of comparing a considerable number of specimens collected from widely different localities together.

I suspect that the species of this genus are propagated not merely by gemmæ or glomerules, but also by *Zoospores*, contained as in other *Algæ*, *zoosporæ* in the cells, of the aggregation of which these plants are composed.

The affinities of the genus are by no means direct, in their lubricity, in the presence of cilia, and probably in their reproduction by *zoospores* they bear a certain relationship to the family *Chætophoreæ*.

a. *Filaments exceedingly flexible.*

1. BATRACHOSPERMUM BOMBUSINUM *Bory.*

Plate XIII. Fig. 3.

Char. Frond *delicate, filaments sparingly branched, branches simple.* Cells *much elongated.* Verticilli *minute, distant.*

"*Batrachosperma* (*bombusina*) *filamentis ramosis; articulis elongatis; verticillis minutissimis, distantibus conoideis.*" — Bory de St. Vincent, Annales du Museum, vol. xii.

Hab. Malahide near Dublin: *Dr. Coulter.*

"This beautiful plant grows in the Isles of France and of Re-union. It covers pebbles in places exposed to the currents of great rivulets, particularly at the Great River and the river of Saint Denis.

"Its colour is of the most elegant green; but if the specimens of this plant be not quickly prepared, they very soon turn black upon the paper.

"From a principal filament from two to four inches long, proceed many long slender loose branches, simple, or having sometimes here and there scattered very small branches, which are never divided. The articulations of the principal stem, and of the larger branches are for the most part naked; their point of contact is dilated in such a manner as to resemble the rods of bamboos.

"As to the verticilli, they are rounded, smaller than those of the following species, composed of very compact branchlets. Their simple ramuli are likewise shorter than in the other *Batrachosperms;* three or four rounded joints compose them: the ciliform appendage which terminates them is remarkable. Some ramuli, shorter than those of the verticillum, cover also the inferior part of the articulations, which have the appearance of reversed cones." — *Bory.*

Bory's descriptions and figures of this species are so accurate, as to leave no doubt either as to its specific distinctness, or its identity with the plant collected by Dr. Coulter.

The exact correspondence of the specimens collected in the Isles of France and of Re-union is remarkable with those found in Ireland, and helps to confirm the opinion which I have long entertained that the different species of the freshwater division of the *Algæ* are almost universally diffused.

2. Batrachospermum helmintosum *Bory.*

Char. Filaments *branched, pyramidal, naked below; branches simple, subpinnate, acute.* Verticilli *contiguous, compressed.*

Bory, in Annales du Museum, vol. xii. p. 316. pl. 29. fig. 2.; *Corallina pinguis, ramosa viridis,* Vaill. Paris, 4to. tab. vi. fig. 6.

Hab. New River, Cheshunt: *A. H. H.*

"There is no doubt but that Vaillant's plant is also our plant: the figure which he has given of it is inferior; the disposition of the branches is badly given; but the tubercles in it are confounded. The extremities are subulate, and the author compares his *corallina* to a *muscus filicinus.* I have moreover gathered the species in question in the place in which the Parisian botanist has pointed out for his habitat. I then discovered it for the first time upon the rocks in the gloomy bosoms of very many freshwater fountains situated in Brittany, beside the river Goesne, near the city of Fougère.

"The stems of this beautiful species scarcely exceed two inches in length. They are fine, and denuded at their base, which appears yellow. Numerous branches proceed from it: they are somewhat subulate, and diminish in length, in such a way, that they incline from the extremities of the plant, which gives to it a pyramidal appearance.

"The verticilli are compressed, voluminous, horizontal, and so approximated, that they cannot acquire the globular form: they become confused, and form around the stems a continuous cylinder of mucosity. The diameter of this cylinder equals often that of the plume of a little bird. The branches are not less thick at their insertion. The colour of the plant is obscure, of a bluish and uncertain green."

3. Batrachospermum confusum *Hass.*

Plate XV. Fig. 1.

Char. Frond *large.* Filaments *much branched.* Verticilli *contiguous, subconfused, compressed above and below.*

Conf. gelatinosa Dillw. Brit. Conf. *Bat. ludibundum* (*var. confusum*) Bory, in Annales du Museum, vol. xiv. p. 320. pl. 29. fig. 3. no. 63.; Gir. Chantrans. Mycros. p. 175. pl. 25.

Hab. Lea well, Devonshire: *W. H. Harvey.* In a small brook in Clive Wood, Swansea: *Dillw.*

Under the name of *Batrachospermum ludibundum* Bory describes seven different varieties of *Batrachospermum:* many of these are indigenous to Great Britain, and several of them doubtless, are distinct species, in which light the plant under consideration ought to be regarded.

"This variety is not rare; it grows in the closed basins of very pure and cold fountains. It there appears to choose shady places. It is found in the holes of rivers, whose waters carry no mud. I have observed it in France, in Spain, in Germany, in Poland, and in Ducal Prussia.

"Of all *Batrachosperms*, this acquires the greatest dimensions: its length is sometimes four inches and a half, its diameter equal often to that of the culm of grasses. Its branches appear also to be less obtuse than in the following varieties. The globules or whorls are so approximated and so large that they are often confounded together in such a manner, as to be with difficulty distinguished in certain specimens which have the aspect of *Batrachosperma helmintosa.* The colour of the plant is of a mouse grey, agreeable by its transparency. The large stems approach a little upon yellow. These tints become of a beautiful violet by putrefaction.

"It is upon individuals of the variety which now engages us that I made, for the first time, twelve years ago, an experiment which ought to be known; after having many times carried from one locality to another stones bearing individuals of this species, which continued to prosper in spite of the change of habitation, I steeped many of them in lukewarm water, afterwards in boiling, and no part of the *batrachosperm* appeared, under the microscope, to have undergone the slightest disorganization by these immersions, and certain sprigs replaced in their native place continued to vegetate after these experi-

ments. I do not think that there exist other vegetables which boiling water does not immediately disorganize; there are not others that can resist temperatures so opposite." — *Bory.*

This species differs from *Batrachospermum helmintosum* by its stems, which are never denuded below, but always verticillate, and by its branches, which are more obtuse, less thick at their insertion, and furnished with many secondary branchlets. I am not certain however that the *B. helmintosum* is anything more than a variety, which the following may be also.

4. Batrachospermum stagnale *Hass.*

Char. Frond *yellowish green.* Filaments *thick, branched.* Whorls, *distinct, slightly compressed, in the trunk confused.*

Batrachospermum ludibundum (*stagnale*) Bory, Annales du Museum, vol. xii. p. 325. pl. 30. fig. 5. *Conferva fontana, nodosa; spermatis ranarum instar lubrica minor et viridis,* Dill. Musc. vol. xvii. f. 44. *Conf. stagnalis, globulis viridis, centibus mucosis. Chara batrachosperma* Weiss, Plant. Crypt.

Hab. Cheshunt, Herts: *A. H. H.*

"Roth (Cat. Bot. i. 126. No. 11. 187.) referred this last synonyme of Dillenius to a variety (β) of *Batrachospermum moniliforme:* he has since regarded this variety (Cat. Bot. iii. 161.) as appertaining to his *Conferva mutabilis,* which is one of our *Draparnaldiæ;* but certainly the figure cited by Dillenius and his phrase applies perfectly to the *Batrachosperm* which is here under consideration, and cannot be applied to any other plant. The rounded and very distinct globules, which the English author represents, have no kind of resemblance to the scattered tufts of the *Conferva mutabilis* of the German naturalist. As to the figure 43. of the 'Historia Muscorum,' there is no doubt that it represents the same plant as the figure 44. There is absolutely no difference but in the length of the branches, which proceeds from the age of the specimens represented. The stagnant variety of *Batrachospermum ludibundum* has great resemblance in form and diameter to

Batrachospermum confusum ; it is nevertheless shorter, but as thick. Its whorls are round and distinct; they are more approximated the one to the other in the large stems, about which they are sometimes even confused. Their colour is a greenish yellow, pale, and livid.

" This plant is found in ditches and in the most tranquil fountains. I have even seen it in marshes fixed against scirpes and stakes."

5. BATRACHOSPERMUM MONILIFORME *Hass.*

Char. Frond *blackish brown.* Whorls *of the stems, distinct, spherical, in the branches confused.*

Batrachospermum ludibundum (*moniliforme*) Bory, in loc. cit. xii. p. 322. pl. 30. fig. 1. *Conf. fontana, nodosa, spermatis ranarum instar lubrica major et fusca,* Dill. Musc. p. 36. t. vii. fig. 42. *Chara* (*gelatinosa frondibus gelatinosis filamentosis: filamentis capillaribus tenuissimis. Verticillis approximatis moniliformibus,* Roth. Cat. i. 125. *Batrachospermum* (*moniliforme*) *filis ramosis; ramis alternis pollentibus, &c.,* Roth. Cat. Bot. iii. 160. *Batrachospermum moniliforme* Vauch. Conf. 112. t. 1. fig. 5. et tab. ix. fig. 4.

Hab. Plassey, near Limerick: *W. H. Harvey.* Upland mountainous district 14 miles west of Aberdeen: *Dr. Dickie.* Galway: *M'Colla.* Hill of Fare: *Dr. Dickie.*

" This variety is the commonest of all. It is frequently met with in fountains, in rapid rivers, and even in waters almost stagnant; it is sufficient that they are pure. It has some resemblance to the variety *B. confusum;* but it is more slender, and its bearing is more elegant. Its stems are very much divided, and from one to three inches long; the globules which cover them are round, distinct, and appear to hold each other only by their poles. They are, however, confused in the last branches, which resemble little worms.

" The colour of the *B. moniliforme* is deeper than that of

B. confusum; it is also more solid, and changes less in dying: it takes nevertheless sometimes a tint of pale violet or a livid yellow."

6. Batrachospermum pulcherrimum *Hass.*

Plate XIV. Fig. 1.

Char. Frond *violet grey.* Whorls *spherical, distant, distinct in the stems and branches.*

Bory, in Annales du Museum, xii. 323. Pl. 30. fig. 2.

Hab. Stream near Cheshunt: *A. H. H.* Near Tunbrigde Wells: *Mr. Jenner.*

"The extreme elegance of form and of colour renders this *Batrachosperm* remarkable; its stems are rather more branched than those of the variety (*a*) *B confusum*, and less than those of (γ) *B. moniliforme*, are from two to three inches and a half long, slender, and of an intermediate diameter. The globules are perfectly spherical, distant upon the stems from each other the length of a ray, more approximate, flattened, but always distinct in the branches.

"Its colour is a clear grey, approaching to a most agreeable violet. This last tint becomes dominant in drying, and passes sometimes to red."

This description applies closely to the plant, which I have twice met with, in all respects save colour, my specimens when recent being of a pleasant green, which in drying became blackish — a tint which the specimens which I received from Mr. Jenner likewise presented, and yet I can scarcely consider them other than the *Batrachospermum ludibundum* (*var. pulcherrimum*) of Bory.

7. Batrachospermum vagum *Ag.*

Plate LXIII. Fig. 2.

Char. Filaments *subdichotomous, much branched, everywhere covered.* Whorls *horizontal, compressed, indistinctly confused.*

Batrachospermum turfosum Bory, in Annales du Museum, loc. cit. *Conferva gelatinosa var. vaga* Roth, Bot. i. 127. *Batrachospermum moniliforme var.* (δ) *vagum* Roth, Fl. Germ. iii. 482.

Hab. Appin: *Captain Carmichael.* Summit of Snowdon: *Sir W. J. Hooker.* Loch Phadrich, 2199 feet above the level of the sea, Aberdeenshire, August, 1842: *Dr. Dickie.* Frequent in Ireland: *D. Moore.* Cromaglan: *W. H. Harvey.* Galway: *M^c Colla.* In the stream by the wall near the entrance of the park by the road-side from Rackham to Pulborough: *E. Jenner.*

"M. Thore, naturalist of Dax, first discovered this plant in the environs of the city which he inhabits. I have since met with it in peat holes of our southerly lands in places where the water, although coloured, is pure; it there grows always at a certain depth, and rarely less than from two to three feet.

"In no other *Conferva* is the number of the filaments so considerable as in this. Their total diameter equals that of the largest horsehair. They divide in every direction from a little disc, ramify to infinity, observing remarkably well the dichotomous disposition in their first division, their branches becoming subsequently vague. Their total length extends even to four inches.

"From their origin, even to their extremity, these filaments are clothed with microscopic branches, so impacted that the whorls are not apparent in scarcely any direction: with a simple lens they are not better discovered, from which it might be supposed that one was observing a *Thorea.* It is but towards the points of the branches that, by the assistance of a strong lens, they are at last distinguished. These whorls are very closely approximated, horizontal, compressed the one upon the other, and becoming so confused as to form around the filament, which is green or yellow, and very flexible, a continuous down, mucous to the touch, sometimes very pale, more frequently of a very agreeable bluish watery green: this colour is moreover deep towards the point of the

branches. As it grows old the plant turns yellow and is discoloured."

The apices of the branches in young specimens are often dilated, and all the filaments present in this state a greater diameter, and a deeper colour, being usually glaucous green.

Some specimens of what I regard as a variety of this species were sent me by Dr. Dickie. They differed from the species in its ordinary condition in the fact of the lower whorls of the main stems being distinctly moniliform.

8. Batrachospermum alpestre *Shut.*

Plate XIV. Fig. 2.

Char. Frond *black, very mucous, much branched; alternately forming very obtuse angles with the principal filaments.* Whorls *of the stems spherical, distinct, but approximate, branches compressed.*

Batrachospermum alpestre, Shuttleworth's MS.

Hab. River Lea, Cheshunt: *A. H. H.* Ireland: *W. H. Harvey.*

It is now some three or four years since I first encountered this species, from which time I regarded it as distinct from any described British *Batrachospermum*, an opinion which I was happy to have confirmed recently by the receipt of a specimen marked *B. alpestre* Shuttleworth, and which exactly accords with my own in all respects, except in being much smaller. At the same time, Mr. Harvey, to whom I was indebted for the authentic specimen of *B. alpestre*, sent me a second example collected by himself, with the observation affixed to it, "very like *B. alpestre*, but I have not examined it."

This species is easily recognised by the eye alone, either in its recent or dried state; in the former its size, great lubricity, jetty black colour, and approximate, yet for the most part exactly spherical whorls, are remarkable; in the latter, in which also the black tint is preserved, it may be distinguished by the multiplicity of its branches, which are, except the pri-

mary ones, exceedingly short and irregular, and issue from the main filaments almost at right angles, and by their non-moniliform appearance. In drying, also, it shrinks considerably. It is a well marked, but apparently not an uncommon species. I am not able to refer it to any described by Bory.

My specimens were met with during the summer in a rapid part of the river Lea, near Waltham Abbey, attached to piles of wood, which they almost covered. The length of some of them reached to four inches; their great size, the elegance of their movements, and their dark colour, at once struck me, and made me desirous of securing specimens, which it was not easy to do in consequence of the depth at which they grew. I succeeded, however, in obtaining a few at the imminent risk of immersion.

9. Batrachospermum proliferum *Hass.*

Plate LXIII. Fig. 1.

Char. Frond *grey, branches irregular, divaricate, beset with short ramuli, which are pinnate.* Whorls *of the stems approximate, compressed, almost confused, in the pinnate branches, subdistant, distinct, formed of very few filaments.*

Batrachospermum moniliforme, B. proliferum, Carmichael.

Hab. Appin: *Captain Carmichael.*

I have seen but one specimen of this curious and interesting species, for an examination of which I was indebted to Mr. Harvey: not the slightest doubt, however, remains on my mind of its distinctness; it is certainly no less distinct than rare. Captain Carmichael, to whom algologists are deeply indebted, for numerous additions to both the marine and freshwater divisions of the *Algæ*, and whose powers of observation were of a very high order, thus in his MS. describes the plant in question. "Frond. solitary or in small clusters, one or two inches long, irregularly branched; branches divaricate, curved or flexuous, opaque and very dark coloured, beset with short ramuli, which issue out from

the joints among the whorls of eccentric filaments, and are themselves beset with whorls; colour grey."

10. Batrachospermum rubrum *Hass.*

Plate XV. Figs. 2, 3.

Char. Filaments *much branched.* Branches *divaricate, alternate, ramuli broad, expanded.* Whorls *of the stems spherical, distinct, subdistant, large, those of the branches altogether confused.*

Batrachospermum moniliforme var., Penzance, June, 1839: *Mr. Ralfs.*

This is one of the most curious, as well as distinct species of the genus. I have seen but a single specimen of the plant, but this is quite sufficient to establish it as a species. This specimen was sent to me, amongst other good things, by my friend Mr. Harvey, and belongs to the Herbarium of Trinity College, Dublin, to which Mr. Harvey, I believe, has generously presented the whole of his collection of *Algæ*.

Batrachospermum rubrum might possibly be mistaken for *Thorea ramosissima*, on account of its mode of ramification, its colour, which is bright red, and, above all, the expanded branches, which are so like those of *T. ramosissima*, that if it were not for the whorls on the main stems, the species might readily be referred to the genus *Thorea*, an error which even a microscopic examination of the plant would not at once remove. If one of the whorls be submitted to the microscope, it will be found to be composed, in part, of slender filaments slightly beaded, and, in part, of other still more slender threads, which are cylindrical, and from which the first set of filaments would appear to arise, and both of which are mixed together; and again, if a portion of one of the branches be examined from which the whorls have disappeared, it will be seen to be composed almost entirely of the exceedingly minute, and occasionally branched threads, with here and there attached to them a single pyriform cell (see fig. 3)., which is to be regarded either as the rudiment of the

ordinary beaded threads of which the branches are composed, or as a capsule, but probably the former. It is thus seen that this species is remarkable both in appearance and structure.

11. BATRACHOSPERMUM ATRUM *Harv.*

Plate XVI. Fig. 12.

Char. Filaments *very much ramified.* Whorls *distinct, distant, short, in the form of reversed cones, opaque; inferior portion of the articulations pellucid.*

Lemania (*batrachospermum*) *filamentis ramosissimis elongatis; nodis superne incrassato opacis, inferne alternatis pellucidis,* Bory, in Annales du Museum, xii. 188. *Batrachospermum moniliforme* (*β*) *detersum* Ag., Hook. Brit. Flor. *Batrachospermum atrum* Harv. in Manual, p. 120. *Conf. atra,* E. B. t. 690.

This species is, perhaps, the most elegant of the genus; it grows generally in still, though pure waters. Although placed by Bory in his genus *Lemania,* it cannot be said to have any near structural relation thereto.

The articulations or internodes may be compared to reversed cones, the superior part or whorls being formed of a few short, simple, subulate filaments, which are not beaded: in these filaments the colouring matter chiefly resides, and it is amongst them that the glomerules are formed: that portion of each articulation, which is below the whorl, is transparent, and beautifully exhibits the tubular and jointed structure of the layers which invest the primary cells in all the species of the genus *Batrachospermum;* from many of these tubes, short branches are given off, which have almost the appearance of scales.

It is probable that there are several varieties of this species which have all been confounded together. Bory describes two, both of which, I believe, I have recognised.

a. SETACEUM. — Filament *slender, long, cærulescent.* — Bory, in Annales du Museum, xii. 188. pl. xxii. fig. 3.

Chantransia atra, nigrescens, filamentis ramosis tenuissimis; articulis longis teretibus; geniculis, subrotundis ciliatis, Cand. Syn. No. 120. *Chantransie noir,* Cand. Flor. fr. 2. 120.

Hab. Ferring, near Arundel: *Mr. Jenner.*

"The filaments of this variety are exceedingly fine, and often almost imperceptible. They dispose themselves with grace upon paper; their internodes are a little oblong, and less inflated towards their superior part than in the following variety."— *Bory.*

β. CAPALLINUM? — Filaments *somewhat thick, black.* — Bory, in loc. cit. pl. xxii. fig. 4.

Hab. Cheshunt Marshes: *A. H. H.*

"The filaments of this variety are of the size of *Chara*, a little shorter than those of the preceding; they appear firmer and blacker.

"It dwells frequently with the large varieties of *Conferva gelatinosa* of Linnæus, and appears to love to entwine itself with it." — *Bory.*

"I have bestowed nearly all my attention upon our native Swiss Plants; for I had to pursue, at the same time, anatomy and the practice of Physick: being unlike you the consecrated priest of Flora. I have always cultivated Botany, in spite of all obstacles, since the year 1728, when I accomplished a laborious journey of 200 leagues through the Alps, on foot. I have since visited those mountains ten successive times. But I am near-sighted, which is a great inconvenience. I have laboured much at Mosses and such plants. I hope to settle a good many doubtful matters, though many must remain undetermined. My family are always finding fault with my pursuit; but I do not repent. On the contrary, I regret that I did not devote more of my time to these things."

"Farewell my dear Linnæus, may you enjoy your health and your botanical pursuits with every advantage for the prosecution of your labours! My studies and engagements, of a different kind, draw me unavoidably aside; but my inclination always leads me to the charms of Flora. To Botany I wish to devote my leisure, my old age, and my fortune." — *Haller to Linnæus.*

Fam. VII. CHÆTOPHOREÆ.

Char. Algæ *gelatinous, ramose, composed of principal stems and smaller filaments, for the most part ciliated.* Reproduction *usually by means of zoospores contained in the filaments, but in some cases said to be capsular.*

The species of this very natural family accord with the preceding in being composed of two sets of filaments, in their extreme lubricity, and in their branches terminating in long ciliform appendages, to which, in a measure, their great lubricity is attributable. They differ from it, however, in the secondary branches not being whorled, in the absence of glomerules, and of the fibrillæ surrounding the primary cells, also in being of a light and beautiful green colour, which, in drying, does not change to some other tint, as has been seen to be the case in the *Batrachospermeæ.*

The two families, likewise, agree in habit, the *Chætophoreæ,* like the *Batrachospermeæ,* dwelling in fresh and pure water, such as that of fountains and slow streams; but on account of the delicacy of their structure they are not met with in large rivers or streams, the force of whose current is strong, and which would sweep them away and destroy them.

On certain species of the genus *Chætophora* capsules have, from time to time, been met with, but the occurrence of these is exceedingly rare, and it cannot be supposed that the ordinary and usual mode of reproduction is by means of these. The true reproductive bodies in this family, as well in all probability as in that of the *Batrachospermeæ,* are undoubtedly zoospores. If a specimen of *Draparnaldia, D. glomerata* for example, be examined microscopically in its young state, the main filaments will be seen to be quite cylindrical: at a later period, however, the cells, of which these filaments are composed, swell up, and the filaments then become beaded. This inflation of the cells, which occurs in almost all the

branched *Algæ*, is indicative of the period of reproduction, and terminates in the rupture of the individual cells, the zoospores escaping through the apertures thus provided. That this is the usual and true method of reproduction it is easy to satisfy oneself in the following method. If a specimen of *Draparnaldia glomerata* be kept in water, which ought not to be renewed for a day or two, the cells will be observed to separate from each other, and, floating on the surface of the fluid, will be noticed a greenish pellicle: if a portion of this be placed beneath the microscope, it will be found to consist of a slimy material, in which are contained numerous green globules of very minute size; these, if watched for a day or two, will be seen to take on the characters peculiar to the species.

The following observations in M. Decaisne's Memoir on the Classification of the *Algæ* in the Annales des Sciences Naturelles occur, which correspond closely with the views already expressed in reference to the reproduction of the genus *Draparnaldia*, and which I have long entertained.

"The *Draparnaldia glomerata* is composed, as it is known, of a principal trunk formed by a series of large cells placed upon each other, transparent, each occupied with a ring of green matter, rather pale, mucous, and mixed up with amylaceous globules. The branches, which arise from the points of junction of these cells, are themselves composed of articulated ramuli, and terminated by a confervoid ciliform thread, which, all united, produce the mucilage with which the plant is found enveloped.

"At the period when it has attained its complete developement, the hairs are seen to detach themselves successively from the last joint: afterwards the green substance enclosed in each of the ramuli unites into little globules, which escape one after the other by a rounded aperture 'pratiquées' upon each of the cellules. These themselves become absorbed (*se* resorbent) as soon as they are empty, so that at a period more advanced, one finds of all the plant but a single filament enveloped with mucus and filled with green globules.

"I believe that I am able to conclude from these observ-

ations that each of the cells of *Draparnaldia glomerata* ought to be considered as a receptacle whence the reproductive bodies formed at the expense of the green matter issue under the form of rounded vesicles themselves being filled with endochrome." — *M. Decaisne, Mémoire sur la Classification des Algues*, p. 314.

8. DRAPARNALDIA *Bory.*

Char. Filaments *free, not immersed in gelatinous fluid.*

Draparnaldia Bory, in Annales du Museum, vol. xii. *Charospermum* Link, in Hort. Phys. 5. *Batrachospermum* in part, Vauch. Hist. des Conf.

"It is to Draparnard that I dedicate this genus, which forms the subject of this new memoir. Those who have been acquainted with that naturalist, alone know all that he was capable of: active, indefatigable, he was fitted for studies the most diverse. Wise and prudent, also timid in his researches, he hastened not to publish; he collected facts, he matured them, he wished his works to be without reproach. Misfortunes and death have surprised him before the execution of his projects, his career is closed before his writings have established his reputation. Scarcely a few phrases, escaped from his pen, and committed to paper, remain; and the loss of treasures which he had collected in his memoirs occasions the greater regret to those who loved him for cherishing the sciences as he cherished them.

"I could doubtless have selected, amongst so many rare and new vegetables which presented themselves to me in my voyages, — I could have found, I say, some genus more analogous to the beauties of his spirit, upon which to place the name of Draparnard; majestic palm trees, brilliant with vigour, reigning over the forest, should perpetuate his remembrance. But the modest manes of my friend, have they not approved my choice? They will smile on that which I have done. May his name live amongst the *Confervæ*, which were his dearest study!" — *Bory.*

Kützing refers the genus *Draparnaldia* to his *Ectospermeæ*,

placing it immediately before *Ectocarpus*, and of course assigning to it lateral external fructification. Certain species hitherto associated with the genus *Draparnaldia* Kützing has removed therefrom; these are *D. stellaris*, which may be identical with my *D. condensata*, and *D. tenuis*, and constituted a new genus for them, under the name of *Stygeoclonium*: this genus is not even placed in the same family with *Draparnaldia*, but in that of *Ulothriceæ*, of which *Lyngbya zonata* forms the type. The following are the definitions of the family and genus.

"*Ulothriceæ*.

"Trichomata mucosa tenerrima, cellulæ coleogonimicæ, substantia gonimica in fascias transversales disposita, postremo in opseospermata hologonimica plerumque quadripartita transiens."

"*Stygeoclonium* Ktz.

"Trichoma tenerrimum, ramosum, ramulis simplicibus subulatis obsessum; cellulæ gelineæ tenuissimæ, abbreviatæ; amylediæ in fasciam transversalem collapsæ, tandem in opseospermata quaternata turgida transeuntes."

I cannot myself think that any essential difference exists between the reproduction of *Draparnaldia tenuis*, &c. and other *Draparnaldiæ*. I have myself occasionally observed the quaternary division of the endochrome in the smaller branches of, I believe, all the species of *Draparnaldiæ*: the circumstance of the occurrence of this disposition in certain species of the genus more frequently than others does not seem to me to call for their separation from that genus altogether; yet Kützing has not merely formed a new genus for them, but has referred this genus to a distinct family, — a family which does indeed manifest a close affinity with *Draparnaldia*, but which Kützing places in his arrangement at some distance therefrom. The genus *Lyngbya*, of which *L. zonata* forms the type of the family *Ulothriceæ*, accords with *Draparnaldia* in the extreme mucosity and flexibility of its filaments, in possessing the second mode of growth of the cells, viz. that of lateral developement, in the endochrome being arranged in

bands across the cells, and essentially in its reproduction. The only real difference between the genera consists in the filaments of the one being simple and those of the other branched. In an arrangement, therefore, in which affinities are studied, these two genera should be placed near to each other.

1. DRAPARNALDIA GLOMERATA *Ag.*

Pl. XIII. Fig. 1.

Char. Stem *round, branched.* Ramuli *in tufts, which are frequently alternate and always ciliated.* Tufts *divergent.*

Hab. Everywhere common in slow streams and ditches, adhering to stones, sticks, &c.

Draparnaldia (mutabilis) gelatinosa; filamentis crassiusculis; ramis subpinnatis, obtusiusculis; fasciculis breviusculis, complicatis, Bory, in Annales du Museum, pl. 35. fig. 1. *Conferva mutabilis* Roth, Cat. Bot. i. 197. Flor. Germ. iii. 518. *C. mutabilis* Roth, Cat. Bot. iii. 282. *C. fasciculata* Thore, Chlor. 444. *Batrachosperme en houpe,* Vauch. Conf. 114. pl. xii. fig. 4. et 5.; Cand. Flor. Fr. ii. 59. *Batrachospermum glomeratum* Cand. Syn. 144. *C. mutabilis,* Eng. Bot. t. 1470. *D. glomerata* Harvey, in Hook. Brit. Fl. p. 388.; in Manual, p. 121.

This species differs in appearance greatly according to its age and place of growth. The younger specimens are of a herbaceous and delicate green, abundantly branched, and the older ones often nearly denuded of branches and almost colourless, becoming so by the escape of the zoospores. When dried on paper the differences between certain specimens of this plant presented to the eye are so considerable that many would regard them as varieties, and almost as species. A microscopic examination would, however, at once remove this supposition.

When first removed from the water, it presents the appearance of a mass of coloured jelly without form or organization: on immersion, however, its branches soon expand. Its fragility is so excessive, that frequently its own weight when fresh is

sufficient to break it, and it is often a matter of considerable difficulty to remove a specimen entire from the water for preservation, each frond breaking as soon as the hand is placed beneath it, and its own gravity is felt, and dividing into many separate pieces, which are slowly carried away by the gentle stream in which the species is usually found. It adheres closely to paper, and does not undergo any considerable change of colour in drying, it also recovers like the *Batrachospermeæ* much of its freshness on being moistened. These last remarks apply to all the species of the genera *Draparnaldia* and *Chætophora*.

2. Draparnaldia plumosa *Ag.*

Plate XII. Fig. 1.

Char. Frond *subgelatinous.* Filaments *gracile, elongated.* Branches *subpinnate.* Tufts *elongated, scattered, approximate to the branches, ciliated.*

Batrachosperme en plume, Vauch. Conf. 113. pl. xi. fig. 2. and 4.; Cand. Fl. Fr. ii. 59. *Batrachospermum plumosum, truncis elongatis; ramulis cauli approximatis,* Cand. Syn. 143. *Draparnaldia hypnosa* Bory, in Annales du Museum, 405. pl. 35. fig. 2. *D. plumosa* Harvey, in Hook. Br. Fl.; in Manual, 121. *Conf. lubrica,* E. B. t. 2087.

Hab. Galway: *M^c^Colla.* Aberdeen: *Dr. Dickie.* Medhurst and Eastbourn: *Mr. Jenner.* Stream near Hoddesdon: *A. H. H.*

This species is more slender, less gelatinous, and attains a much greater length than *Draparnaldia glomerata.* It lives also in purer and deeper water, is usually of a brighter and more beautiful green, and, from being less gelatinous, it is also less fragile. The mode of branching is different in the two species; the tufts in that which is here described are longer, more scattered, approximated to the branches, and not as in the previous species divergent. It is an elegant species. The cells of the stems are usually shorter, and rarely so inflated or oval as those of *D. glomerata.*

3. DRAPARNALDIA REPETITA *Hass.*

Plate XII. Fig. 2.

Char. Filaments *branched, consisting of repeated series of cells, each series composed of five or six cells, which decrease in size from the first or lower cell to the last or upper one, series oblique.* Tufts *dense, alternate.*

Hassall, in Annals of Nat. Hist., August, 1842; also in loc. cit. vol. xi. 428.

Hab. Cheshunt: *A. H. H.*

"I have only once met with the above species, and then but in small quantity: it is therefore no less rare than it is curious. Each series of cells is an epitome of the entire plant, which consists but of an aggregation of such series. A sketch of it was forwarded to Dr. Greville, who did not hesitate to agree with myself in the opinion of its distinctness."

4. DRAPARNALDIA CONDENSATA *Hass.*

Plate XI. Fig. 1.

Char. Filaments *of considerable size, sparingly branched.* Branches *furnished with short cilia.* Cells *abbreviated.*

Hassall, in Annals of Nat. Hist. vol. xi. p. 429.

This is one of the finest and most distinct species of the genus. The only locality at present known for it is a large fish pond opposite Mr. Bosanquet's school for girls in the parish of Wormly, Hertfordshire. It differs from the two preceding species in several respects. It is more sparingly branched, the ramuli are never tufted, and the cilia rarely prolonged: the cells are very short, usually broader than long, and entirely filled with endochrome. The habit of the plant is also different, dwelling in water less fresh, and its colour in consequence is less vivid than in most other *Draparnaldiæ.*

5. Draparnaldia tenuis *Ag.*

Plate XI. Fig. 2.

Char. Filaments *slender, ciliated, sparingly branched.* Branches *usually simple and solitary, but sometimes subfastigiate.* Cells *of the stems twice or thrice as long as broad, those of the branches rather longer than broad.*

Hab. Streams near Cheshunt: *A. H. H.* Reservoir, Ardrossan: *Major Martin.* Between Pembury and Tunbridge; Hawkhurst and Gondhurst, Kent: *Mr. Jenner.*

This is a much smaller species than any of the preceding, is more tenacious, and an inhabitant of streams and rivulets, the current of which is strong. Filaments very slender, four to six inches long, irregularly or alternately branched, more or less furnished with scattered or subfasciculate ramuli, whose tops are either acute or drawn out into long setaceous colourless points. Joints of the main filaments and ramuli coloured or transversely banded. "At first the filaments are enclosed in the manner of a *Chætophora* in a common somewhat definite gelatine; afterwards, on *its* bursting, they issue from it like a *Conferva*, but are at all times very gelatinous." — *Harvey, Manual of Brit. Algæ*, p. 122.

6. Draparnaldia elongata *Hass.*

Plate X. Fig. 3.

Char. Filaments *very slender, ciliated.* Cells *fasciated, usually three times as long as broad.*

Hassall, in Annals of Nat. Hist. for August, 1842; also in loc. cit. vol. xi. p. 4.

Hab. Cheshunt: *A. H. H.* Parkind: *Major Martin.*

The filaments in this species are finer than those of *D. tenuis*, and the cells longer. I have no doubt of its distinctness. It is a rare species, and I have only twice met with it, once growing in a horse trough near Cheshunt.

7. Draparnaldia nana *Hass.*

Plate X. Fig. 3.

Char. Filaments *highly mucous, very slender, sparingly branched.* Branches *acuminate, not usually ciliated.* Cells *rather broader than long.*

Draparnaldia sparsa Hassall, in Annals of Nat. Hist. xi. 428. *Conferva nana* Dillw. Brit. Conf. t. 30.

Hab. Cheshunt and neighbourhood: *A. H. H.* Stevenston: *Rev. D. Landsborough.*

This is by no means an uncommon species during the spring and early part of the summer, being found attached frequently to dead leaves and sticks. In the fineness and mucosity of its filaments, as well as in the shortness of its cells, it seems to exhibit some relation to the genus *Chætophora* (a bad name, since the species of the genera *Batrachospermum* and *Draparnaldia* are likewise *chætophorous*). From *D. tenuis* and *D. elongata* it is distinguished by the absence of cilia, shorter cells, and from the former again by its smaller size.

9. CHÆTOPHORA *Schrank.*

Char. Filaments *imbedded in a gelatinous matrix, which is either globose or lobed, rarely plain and crustaceous; aggregated, branched, articulated, sometimes setaceous, and issuing from a common base.* Branches *nearly colourless.* Ramuli *coloured.* Capsular fructification *has only been noticed in C. pisiformis, C. pellita, and C. tuberculosa.*

Derivation. From χαιτη, a bristle, and φορεω, to bear.

Chætophora Schrank; Lyngb. p. 65, 66.; Fl. Danica, t. 1728.; Agardh, Syst. xix.; Grev. Scot. Fl. t. 150. *Rivularia* Bonnemais, in Jour. Physic. xciv. p. 176. *Myriodactylon* Desv. in Jour. Bot. 1809, p. 307. *Anhaltia* Schwahl, in Linnæa, ix. p. 127. t. 2. fig. 1. 2. *Batrachospermum sp.* Vauch. Conf. t. 12. f. 1, 2. t. 13. fig. 1, 2.

Through *Draparnaldia tenuis* and *D. nana* there is an easy and natural transition to this genus.

Imbedded in the gelatinous matrix, are usually, in the older specimens, a number of stony particles; these have been supposed to be in some way or other connected with reproduction. Vaucher regards them as the ruptured cells of the plant, and destined to reproduce the species.

1. CHÆTOPHORA DILATATA *Hass.*

Plate XIII. Fig. 2.

Char. Filaments *much branched, fastigiate.* Extremities *dilated.*

Hab. Ireland: *Mr. Moore.*

This species I discovered accidentally, mixed up with a specimen of *Nostoc muscorum.* It is very remarkable.

2. CHÆTOPHORA ENDIVIÆFOLIA *Ag.*

Plate IX. Figs. 1, 2.

Char. Mucous matrix *somewhat compressed, sub-dichotomously branched.* Primary branches *frequently parallel; apices of ultimate* ramuli *ciliated.*

Batrachospermum fasciculatum Vaucher, Hist. des Conf. d'Eau douce, p. 116. pl. xiii. fig. 1.; Harvey in Hooker's Brit. Flor. ii. p. 389. *Ulva incrassata,* E. Bot. 967. *Chætophora endiviæfolia* Harv. in Manual, p. 122.

Hab. Common in streams.

"This *Batrachospermum* is more rare than the preceding species *B. moniliforme, B. plumosum,* and *B. glomeratum:* it is met with in slowly running waters, covering stones, to which it is attached, under the form of a little green protuberance irregularly lobed at its extremities. It is but little more than a few lines in length, and about half as broad. It can scarcely be distinguished with the unaided sight, but with the microscope it appears curiously composed. If but a very

small fragment be examined, it will be seen, with surprise, that it is formed of an assemblage of principal filaments, parallel, elongated, and which bear at their extremities subdivisions, very short, composed of three or four branches. The white grains are here seen in great quantity, which proceed from ruptured rings, and are destined to reproduce the plant, so that it is difficult to doubt the destination of these grains, even when this has not been confirmed by direct proofs.

"This *Batrachosperm*, without doubt, has not yet been described, and it is necessary to observe, that it is difficult to discern at first sight a *Conferva* in the gelatinous material which forms it, but that which is obscure to the simple sight becomes distinct to the microscope."— *Vaucher.*

Mr. Harvey, in his description of this species, compares the mode of branching of the frond to stags' horns, a comparison which conveys a very good idea of the appearance of this beautiful object.

3. CHÆTOPHORA TUBERCULOSA *Hook.*

Plate IX. Figs. 7, 8.

Char. "Gelatinous matrix, *at first glabrous and firm, afterwards much lobed, fragile, and hollow.* Filaments *very slender, flexuous, hyaline.* Ramuli *coloured, palmate, fasciculate.*" — Harvey.

Harvey, in Hooker's Brit. Flor. *Rivularia tuberculosa*, E. Bot. t. 2366. *Ch. tuberculosa* Harvey, in Manual, p. 122.

Hab. Diana Pond, Bushey Park: *A. H. H.* Aberdeen: *Dr. Dickie.* Neighbourhood of Manchester: *Mr. Sidebotham.* Barnett's Wood, near Tunbridge Wells: *Mr. Jenner.*

"On sticks and aquatic plants in boggy pools. Fronds bright green, an inch or more in diameter." — *Harv.*

It is doubtful as to whether this is to be regarded as any thing more than a variety of the following species, *C. elegans*, the *Batrachospermum intricatum* of Vaucher, or that species much developed; the softness and hollowness of the matrix both resulting from the extraordinary developement.

In English Botany the filaments are figured without cilia. Kützing also figures them in the same manner: if this character be permanent, then is the species doubtless a good one.

The following observations, taken from the "Flora" for 1842, p. 513., were inserted in the "Annals" for June, 1843:—

"The fruit of *Chætophora* appears hitherto to have been observed only by Mr. Berkeley, who communicated specimens to Captain Carmichael, who made a drawing from them; which, with his other manuscripts, is in the hands of Sir W. J. Hooker. Mr. Berkeley also published a figure of it in his "Gleanings of British Algæ." Dr. Müller of Detmold has been so fortunate as to meet with similar fruit in *Chætophora tuberculosa*, and has given figures of it in the place cited above. He has made, moreover, a very curious observation, viz. that the fruit is accompanied by, and at length connate with, a red globule of a similar form but smaller size, which he considers as the male fructification. As the female capsule advances to maturity, the male approaches it, becomes elongated, and at length is united with it, emptying the pollen globules into the female fruit. This process being accomplished, it falls off.

"Whatever may be thought of this, his account of the developement of the spores formed within the capsule, which are about five in number, and disposed around an aperture occasioned probably by the pressure of the male capsule, is not less wonderful. From each of the seeds a hyaline thread is developed, formed of the globules which press forward from the inside of the seed; this at length becomes green, and consists of a very tender hyaline tube filled with a moniliform row of globules. Finally, the uppermost globule is elongated into a new tube, which is of a paler green than the rest of the thread. The capsule is now no longer visible, and the whole resembles a *Rivularia*, which soon assumes the form of *Chætophora tuberculosa*.

"The above observations are at least curious, and, if there has been no error, are of much importance. We recommend them to the consideration of some of our practical algologists, hoping that they may be able to throw some light upon the matter."

4. Chætophora elegans *Ag.*

Plate IX. Figs. 3, 4.

Char. Mucous matrix *subglobose, or lobed, rather solid, green.* Filaments *subdichotomous.* Ramuli *fastigiate, the apices produced beyond the gelatine and setigerous.*

Batrachospermum intricatum Vauch. Hist. des Conf. d'Eau douce, p. 117. pl. xii. figs. 2, 3. *C. elegans* Harvey,

in Hook. Brit. Flor. p. 389.; also in Manual, p. 122. *C. elegans* Ag.

Hab. On sticks, &c., in stagnant pools, common.

"No species is more easy to recognise; it is formed of gelatinous protuberances of all sorts of figures, and of a diameter which varies from a point to an inch." — *Vaucher.*

5. CHÆTOPHORA PISIFORMIS *Ag.*

Plate IX. Figs. 5, 6.

Char. Frond *subglobose, fleshy, green.* Filaments *subdichotomous, obtuse.* Sporidia *globose, axillary.* — Carm.

Harvey, in Hooker's Brit. Flor. p. 389.; Berk. Algæ, l. 1. fig. 1.; Grev. Crypt. t. 150.

Hab. In subalpine lakes.

Mr. Berkeley has discovered capsular fructification on this species, and Kützing has figured similar capsules as belonging to *C. tuberculosa.* The occurrence of these capsules must be regarded as excessively rare, and therefore commonly considered as the only mode of reproduction possessed by species which are everywhere so abundant.

6. CHÆTOPHORA LONGÆVA *Carm.*

Char. "Frond *indefinitely effused, incrusting, gelatinous, green.* Filaments *subdichotomous.* Ramuli *produced proliferous towards the apex.*" — Carm.

C. longæva Harvey, in Hooker's Brit. Flor.; also in Manual, p. 123.

Hab. In a boggy stream at Appin: *Captain Carmichael.*

"Fronds, continuous, or so closely set as to have that appearance, of a delicate green colour, and more flaccid than those of *C. elegans,* apparently from a deficiency of gelatine. Filaments in all respects similar to those of other species, excepting in being mostly proliferous."

I cannot regard this as a distinct species, and would refer to it *C. endiviæfolia* or *C. tuberculosa.*

Fam. VIII. CONJUGATEÆ.

Char. Filaments *simple, equal, often conjugating.* Endochrome *mostly figured.* Sporangia *formed generally by the union of the contents of two cells, either in different or in the same filaments.*

The *Confervæ*, which we now propose to examine, are perhaps the most curious of all their tribe. When viewed together, they form an exceedingly natural group, but one which is defined rather by the enumeration of a number of characters than by one in particular.

Their filaments when examined with the microscope are seen to be simple and of uniform diameter; they are for the most part unattached, and in their young condition are smooth and unctuous to the touch, and of a deep green colour: they are formed of an assemblage of elongated cells placed end to end, and all of them enclosed and held in union by an investing membrane, common to all, the interior of these cells being occupied, chiefly with endochrome, which is variously disposed, sometimes in the form of spires and stars, at others it completely fills their cavities: mixed up with this endochrome, are observed numerous vesicles; these being it is presumed the unfertilized zoospores.

When the filaments have attained a certain age or period of developement, most of the cells are seen to send forth a little conical process, which unites with a similar protrusion from a corresponding cell of a contiguous filament, an uninterrupted passage of communication between the two cells being thus established.

While this is occurring, the spiral tubes, if the species be a *Zygnema*, become confused and coalesce in each cell, the contents of one passing out through the passage of communication, mingling with those of the other, and both uniting, are at length moulded into a dark body of either an oval or circular form, and enveloped in membranes; and which Vaucher,

M. Decaisne, and Mr. Jenner regard as the true spores, but which, Agardh declares, resolve themselves after a time into zoospores, an opinion in which I concur, applying the term sporangia to them.

The tubes of communication do not appear to issue from any determinate point of each cell, but from that which lies in nearest contact with a neighbouring filament; the filaments appearing to exercise a mutual attraction on each other: thus a number will be given off in succession to corresponding ones of a filament near to it on one side, while another set from the same filament will unite with those of another coming near to it in some other part of its length.

It is curious to remark that the cells in one part of the same filament will part with their contents and remain empty, while in another, they will be the recipients of the contents of the cells of another filament.

This remarkable mode of union of the filaments, almost without parallel in the vegetable kingdom, was first noticed by Müller in a species which he named *Conferva jugalis*. Müller, however, did not entertain the slightest suspicion that it was in any way connected with reproduction.

Since the time of the publication of Vaucher's "Histoire des Conferves d'Eau douce," in 1803, but little seems to have been added to the information contained in that excellent work in reference to this division of the *Algæ*, in which the phenomenon of union of the cells is shewn to belong to very many species, which Vaucher for the most part has satisfactorily determined, notwithstanding the feeble power of the instrument employed by him in their investigation. The labours, however, which I have bestowed upon the fresh-water *Algæ* have been rewarded with a few discoveries of interest, one of which I shall now proceed to notice.

This relates to the fact, that certain species of *Conjugateæ*, belonging principally to the genus *Zygnema*, occur, in which there is no union of the different filaments similar to that already described; the sporangia being formed in these by the concentration of the matter of two cells *in the same*, and not as in the preceding case *in different filaments*. This interesting fact was first announced by me in a paper on the *Zygne-*

mata inserted in the 9th vol. of the "Annals and Magazine of Natural History," p. 34. Since this paper was published I have observed, in Dillwyn's "Synopsis of the British Freshwater Algæ," that a non-conjugating *Zygnema* has been described accurately by Mr. Woods, under the idea of its being a variety of *Zygnema quininum*. The accuracy of the description would appear, however, to have been doubted, since we find no reference to the species, which is distinct, and not a variety of that to which it was referred, made by subsequent writers on the *Algæ*. Mr. Harvey in his excellent "Manual" does not make any mention of it.

In these non-conjugating *Zygnemata* the tubes of communication issue from the opposed extremities of the cells, and not from the centre of the sides of the cells, as in the conjugating *Zygnemata*.

The analogy which exists between the conjunction of the filaments of the *Conjugateæ* and the reproduction of animals has led to the opinion being entertained by some that they are animal and not vegetable productions. The erroneous nature, however, of this view is easily proved by reference to the non-conjugating species mentioned, these testifying that the conjunction of the filaments is not an occurrence essential to the perpetuity of the species, and that therefore no arguments in favour of the animality of the *Conjugateæ* ought to be founded on that circumstance. The union, however, of distinct cells in the same filament might be regarded as indicative of an animal nature; but this view may be disproved by reference to another genus of freshwater *Algæ*, of the vegetability of which there can be no question, viz. *Vesiculifera*, in which there is an union of the matter of two cells in the same filament, though no tubular connection between those cells. Now the analogy between the species of this genus and the non-conjugating *Zygnemata* is too great to permit of the opinion being entertained, that the former are vegetables and the latter animals.

Some have accounted for the union of the filaments by supposing that the entire of one filament contained fertilizing and the other fertilizable material; but this view is likewise shown to be erroneous by the occurrence of non-con-

jugating species. If two kinds of reproductive matter exist, as most suppose, they must both be contained in the same filament in these species; but even this view cannot be received when it is known that certain species of the family *Conjugateæ* occur in which there is not even a union of the matter of two cells, but in which the sporangia are formed separately within each; as in *Mesocarpus notabilis* and *Zygnema mirabile.*

It would thus appear that no argument can be deduced from the conjunction of the cells in the same or different filaments and the commingling of their contents in favour either of the animality or sexuality of the *Conjugateæ,* and that the phenomenon, remarkable as it is, is subservient to some secondary purpose in the economy of these productions.

The species of this group of *Confervæ* may be found occasionally in a state of conjugation during the entire of the spring, summer, and autumnal months; they are chiefly met with, however, in this state in the spring. It is usually some days after this union of the cells has been established, that the slow emanation of the matter of one cell occurs, this transference being occasioned apparently by the mutual attraction exercised by the contents of each cell on that of the one to which it is joined; this attraction, in correspondence with the law of gravitation, being predominant in that cell which contains the greatest bulk of matter; and thus, I think, we may account for the contents of a number of cells of one filament passing to those of another set of cells of another filament, the matter in them being more considerable in quantity.

Very soon after the contents of the cells have united, they are seen to dispose themselves into a regular form, and in the course of three or four days the sporangia are perfected, each being invested with its two or three membranes.

For some time, not unfrequently extending to weeks after the cells have conjoined, and the sporangia have become organized, the species does not appear to undergo any further change: at length, however, the tubes of communication separate, the cells become disjointed, indicating the death of the plant, respiration ceases, and the disunited fragments fall to the bottom of the water, the sporangia being set free on the entire disorganization of the plant or the zoospores bursting

through the membrane which invests them, escape through the open extremity of the communicating tubes.

When in a young condition, and before reproduction takes place, the *Conjugateæ* are of a bright, beautiful, and shining green colour, are highly lubricous to the touch, and the individual filaments are never entangled together, but placed somewhat parallel. As soon, however, as a union of the filaments has occurred, these characters are for the most part lost. The rich green colour fades to a yellow tint; the filaments no longer glisten when removed from the water, or feel slippery, but almost harsh and crisp under the fingers; they are now likewise much curled and twisted. The change of colour is the result of diminished vitality, and the loss of lubricity arises from the extension, amounting almost to obliteration of the sheath.

The *Conjugateæ*, with a single exception, dwell in waters that are perfectly still, such as ponds, reservoirs, ditches, pools, and extended marshes; they are also, with a single exception, unattached, roots not being necessary to them, for, unlike the greater part of the *Algæ* which have hitherto been considered, and which are all provided with rootlike organs, they incur no risk of being swept away by the force of the river, stream, or cascade in which they delight to dwell. The union between the filaments which is to occur, renders a locality of the above description an essential to the very existence of this family of plants, for without absolute quietude of the water this conjugation would be frustrated. In the only attached species with which I am acquainted, and which dwells in flowing water, I have never detected conjugation of the threads.

The *Conjugateæ* adhere strongly to paper, preserving their shining appearance, but never their brilliant colours; these generally becoming almost black in drying.

The quantity of air or gas eliminated by the *Confervæ*, but principally by the *Conjugateæ*, in warm sunny weather is very considerable. It is by means of the globules of air given out by these plants in respiration, that such large masses as are seen in the spring and summer months, covering almost every pond and ditch, are sustained upon the surface,

the globules becoming entangled amongst their filaments render them specifically lighter than the water, and cause them to crepitate under the finger when pressed upon. The presence of these globules in warm weather causes the *Conjugateæ* and other *Confervæ* to present a vesicated or bullous appearance, which the older algologists thought to be characteristic of a single species, which they named *Conferva bullosa*: this appearance is now known to belong to a whole host of *Algæ* generically distinct—such is the progress of scientific research and knowledge. Dillwyn, in his description of *Conferva fracta*, observes, that, "after being dried, the *Confervæ bullosæ* have been used as wadding for stuffing garments, and made into coarse household linen." Weiss, in his "Plantæ Cryptogamiæ Floræ Gottingenses," p. 23, relates, that formerly the river Unstrut, after inundating a large tract of country in Upper Saxony, on again retiring into its proper channel, left a great quantity of *Conf. bullosa*, which having been gathered and dried by the inhabitants, was used by them for stuffing their garments; but that it occasioned violent pains in their limbs: it was also used for making coarse paper." On some parts of the Continent serious injury has been done to large tracts of country, by the deposit, on the subsidence of the waters which have covered them for a period, of a compact layer of these *Confervæ bullosæ*, which has prevented the growth of the grass beneath, and thus deprived the cattle of their food. So great an evil has this been deemed of late years, that commissioners have been appointed to investigate the nature of this deposit, and to endeavour to devise some means to remove and prevent its re-formation.

M. Decaisne, in his "Memoir on the Classification of the Algæ," has, on grounds which, on mature consideration, I cannot regard as satisfactory, separated this group from Agardh's class of zoospores, in which I would retain it; for certain it is that one division of the group of sunspores of M. Decaisne, viz. the true *Conferveæ*, are propagated by means of zoospores.

The numerous species of this group resolve themselves naturally into the genera *Zygnema*, *Tyndaridea*, *Staurocarpus*, *Mesocarpus*, and *Mougeotia*.

10. ZYGNEMA *Ag.*

Char. Endochrome *arranged in spiral order within each cell.* Sporangia *generally oval, and never lodged in the transverse tubes of communication.*

Derivation. From ζυγος, a yoke, and νημα, a thread.

Spirogyra Link, Handb. iii. 261., Meyen, in Linnæa, ii. 410. *Choaspis* Gray. *Salinacis* Bory, in Dict. Class. xv. p. 75. c. iv. t. 45. *Conjugatæ sp.* Vauch, Conf. d'Eau douce.

The first of these genera is characterized by the endochrome with its brilliant granules (which Müller, in his surprise on first discovering a species of the genus, likened to precious stones), being arranged in a spiral form, the number of spires being from one to eight.

The species of this genus admit readily of division into two subgenera, in the one of which the filaments unite, and in the other no conjugation takes place; and each of these divisions allows of further analysis, founded on the conformation of the cells.

"In the first of these subdivisions, which for the most part includes the long-celled species of the genus, such as *Zygnema elongatum* and *Z. quadratum*, &c., the opposed extremities of *all those cells which have attained maturity* are considerably inverted, and which inversion may be compared to that of the finger of a glove (Pl. XVII. fig. 4.); while in the second, which embraces the short-celled examples, as *Zygnema maximum*, *Z. nitidum*, and very many others, the cells are not inverted, but touch each other by their plane surfaces.

"The form of this inversion is, in all the species in which it occurs, identical and extremely regular, its circumference being circular, and its base somewhat flat; no membrane intervenes between the spaces formed by this indoubling in contiguous cells, which spaces therefore communicate directly with each other.

"At the period of reproduction, and at no other, one of the two indented and opposed extremities of certain cells be-

comes everted and protruded into the cavity of the other. (Pl. XVII. fig. 5.)

"The cause of this protrusion, and the reason why it only occurs at the precise period of the reproduction of the cells, are easily accounted for, and both arise from unequal internal pressure of the contiguous cells on each other, which inequality of pressure is produced by the emission of the endochrome of one cell into a neighbouring cell either in the same or different filaments; thus, when a cell has discharged its contents, its cavity is empty, and no resistance can be offered by it to the protrusion of the inverted portion of the adjacent cell or cells, replete as it or they may be with fluid and endochrome. This explanation applies likewise to the fact, that when a number of cells have either emptied themselves of their contents, or have been the recipients of those of other cells *at the same time*, no eversion takes place, for in this case there is no inequality of internal pressure.

"But while a correct exposition may be given of the cause of this protrusion and intromission, it is not so easy to offer a satisfactory explanation of the purpose to be attained by it. The eversion, doubtless, assists in effecting the dislocation of the cells, and thus, reproduction being perfected, hastening the destruction of the species and dispersion of the spores; processes, which, from the greater length of the cells and consequent continuity of the enveloping sheath, would possibly occupy, were it not for some special provision of the nature indicated, a much longer time than in the short-celled species. A subordinate and not unimportant use of this provision is, the assistance which it affords in the determination of allied species.

"It is remarkable that no similar conformation presents itself to our notice in the genera *Tyndaridea* and *Mougeotia*, so closely allied to *Zygnema*, for in these the cells invariably terminate by plane surfaces, which, however, may be either everted or inverted to a slight extent.

"This peculiar formation of the cells of some *Zygnemata* was first noticed by me in the spring of 1842, but its true nature only became apparent to me in the early portion of the present year. When viewed through a low power of the microscope, and in a *Zygnema* whose filaments are as yet

separate, it exhibits the appearance of two curved knife-blades slightly approximating to each other at their apices, near to which usually lies the divided spiral thread, and strongly impressing the superficial observer, from the position and aspect of these blades, with the idea that they are the instruments which effect its separation, and reminding him of the beautiful provision whereby the section of pollen granules is accomplished.

"On transmitting a short time since a specimen of the *Zygnema quadratum*, in a state of reproduction, to the Rev. M. J. Berkeley and Mr. Ralfs, but unaccompanied by any remarks in reference to the structure of the cells, both these gentlemen noticed their peculiar conformation, and from the former I received correct sketches of their appearances.

"The structure of the joints in *Zygnema* was long since noticed in one species of the genus by Mohl, who thus describes it in his paper upon the multiplication of cells by division, inserted in the 'Flora':—'In *Z. elongatum* Ag., the dissepiments have a very peculiar structure, which I have found in no other species. The terminal surface of each cell is not even, but elongated into a blunt conical process. This process can only be observed in its true state when two joints are separated one from the other; when, on the contrary, the threads are unbroken the process is generally introverted like the finger of a glove, and exhibits the form represented at Pl. I. fig. 8. *a*, *b*, *c*. This is the common condition, and in most threads no joint is found otherwise constructed. But I have now met with a single thread in which a part of the articulations has the ordinary length, while another part has joints only half as long. In these shorter articulations it was normal that only the alternate dissepiments had the structure peculiar to this species (so that by these dissepiments the thread was divided into articulations of the ordinary length), while, on the contrary, the intermediate dissepiments exhibited the form usual in *Conferva*."

"The observation, that 'this process can only be observed in its true state (that is, everted) when two joints are separated, the one from the other,' is inaccurate, for the cells may be separated and yet the processes inverted, the eversion of

them having nothing whatever to do with the separation of the cells, and never being in any case the result of it, but depending, as explained already, upon unequal internal pressure, and occurring chiefly at the period of reproduction. The effect of the eversion is, as already observed, to occasion the dislocation of the cells.

"Again, in every filament of those *Zygnemata* which exhibit the inverted structure, cells may be observed terminating in the ordinary manner of *Confervæ*, viz. by plane surfaces, the presence or absence of the inversion depending upon the period of the formation of the dissepiments; the older ones, or, as observed in the beginning of this notice, the more mature ones only presenting it. Thus it follows that the *opposed extremities* of cells always exhibit the *same* structure, and that this alternation in form supplies evidence the most conclusive of the multiplication of cells throughout the *entire filament* of a *Conferva* by division." *

It is in this genus that the radiated organ described in the Introduction is best developed, and may be observed with most advantage; it is here also that the cruciform organs, supposed to secrete the raphides, and the curved strings of cytoblasts, before noticed, are most clearly seen.

Attention to the structure of the cells in the *Zygnemata* is of the very first importance in the discrimination of species, it being the only distinguishing character in some closely allied species.

First Subgenus.—Filaments *conjugating.*

* *Extremities of the* cells *truncated.*

a. Spires *numerous.*

1. Zygnema orbiculare *Hass.*

Plate XIX. Figs. 1, 2.

Char. Filaments *highly mucous, and of a light green colour,*

* From a paper entitled "Observations on some Points in the Anatomy and Physiology of the Freshwater Algæ," by Arthur H. Hassall, inserted in the "Annals and Mag. of Natural History," vol. xii. pp. 26—8.

their diameter and length being very considerable. Cells, *when in a state of conjugation, a little longer than broad, prior to which, however, they are frequently not half so long as broad; winding round the interior of these are about eight spiral threads, the granules in them being small.* Sporangia *almost circular, flattened.*

Z. maximum Hassall, in Annals of Nat. Hist. vol. x. p. 36.

Hab. Cheshunt, Hertfordshire, and the country adjacent; Notting Hill: *A. H. H.* Waldron and Worthing: *Mr. Jenner.* Graham Castle: *Major Martin.*

This is one of the finest as well as largest of all the *Zygnemata* hitherto described, the diameter of the filaments greatly exceeding those of *Z. nitidum*, the *Conjugata princeps* of Vaucher. It is found only in ponds and dykes whose waters are deep and permanent, and it does not conjugate until near the end of the summer. The only other *Zygnema* with which it could possibly be confounded is *Z. serratum*, between which and the present plant several well marked differences exist, as will presently be shown. Two varieties of this plant were described by me in the 11th vol. of "Annals and Magazine of Natural History," p. 432. both of which I now feel assured are quite distinct. The first of these is *Z. alternatum.*

2. Zygnema alternatum *Hass.*

Plate XX.

Char. Filaments *of the same diameter as those of the preceding species.* Cells *rather longer than broad.* Spires *numerous, granules small, conjugation alternate, that is, every second pair of cells alone conjoin.*

Hassall, Annals of Nat. Hist. vol. xi. p. 432. *Zygnema* Decaisne, in Mémoire sur la Classification des Algues, An. des Scien. Nat.

Hab. Cheshunt, Hertfordshire. *A. H. H.*

This is one of the rarest species of the genus, and I am not sure that I have ever met with it more than once. The mode of conjugation of the cells, the alternate ones only uniting, is

curious, and is confined to this and the following species. The design of the interrupted conjugation is by no means evident: it is remarkable, however, that the granules in those cells, which remain disunited, decrease in size and become almost colourless, while those of the conjoined cells increase considerably, and darken in colour. This mode of conjugation at least affords a decisive character by which it and the following species may be known from all others hitherto described. One fact is still wanting to complete the history of this species, viz. the form of the sporangia, which might possibly furnish an additional distinctive character.

3. Zygnema interruptum *Hass.*

Plate XXI..

Char. Filaments *of considerable length, but less in diameter than those of Z. orbiculare.* Cells *at the period of conjugation rather longer than broad: previous to this, however, they are frequently not half so long as broad.* Spires *numerous.* Conjugation *interrupted.* Spire *oval, equalling in breadth the diameter of the cell but not producing any inflation of it.*

Hassall, in Annals of Nat. Hist. vol. xi. p. 432.

Hab. Cheshunt: *A. H. H.*

This also is a very rare species. I have only met with it once, but then in very considerable quantity. It bears a close resemblance to *Z. alternatum*, but differs from it in having filaments which are considerably smaller than those in that species. The granules or unfertilized zoospores are likewise largest in those cells which have conjoined.

4. Zygnema serratum *Hass.*

Plate XXIII. Figs. 1, 2.

Char. Filaments *of nearly the same diameter as those of Z. orbiculare, but less mucous.* Cells *longer than broad.* Spires *varying from three to five in number.* Granules *larger.* Conjugation *continuous.* Sporangia *broadly ovate.*

Hassall, in Annals of Nat. Hist. vol. xi. p. 432.

Hab. Cheshunt, very rare: *A. H. H.* Withyham: *Mr. Jenner.*

The only species with which this can possibly be confounded is *Z. orbiculare*, from which it may be readily distinguished by the fewer number and serrated appearance of the spires, the larger size of the granules, and the form of the sporangia, which in *Z. orbiculare* are nearly spherical, and compressed, while in *Z. serratum* they are broadly ovate. The filaments do indeed resemble very closely in character those of *Z. nitidum*, with which, however, there is but little danger of confounding it, that species being altogether a much smaller plant. It is very rare.

5. Zygnema nitidum *Ag.*

Plate XXII. Figs. 1, 2.

Char. Filaments *of much less diameter than those of Z. serratum.* Cells *usually rather more than twice as long as broad.* Spires *generally four in number.* Granules *large.* Sporangia *acutely ovate.*

Conferva jugalis Müller, Flora Danica. *Conjugata princeps* Vaucher, Hist. des Conf. d'Eau douce, p. 64. pl. iv. fig. 1. *F. nitidum* Harv. in Manual, p. 143.; Agardh's Systema. *Conf. nitidum* Dillwyn, British Confervæ, pl. iv. f. c.; Eng. Bot. t. 1656, in part.

Hab. Every where common throughout Great Britain and Ireland.

This species is one of the best marked as well as most beautiful of the tribe. Numerous other *Zygnemata* have however doubtless been associated with it under the same name.

Vaucher has the following observation upon it: — "Independently of its size, it is distinguished from all others by a coarser touch, a more shining appearance of tubes almost crisp, and by its constant habit of raising its extremities out of the water whenever it is immersed in the liquid."

6. Zygnema belle *Hass.*

Char. Filaments *about a foot in length, with truncate extremities; of considerable though rather less diameter than those of Z. nitidum, mucous, glossy, and of a deep and beautiful green colour; investing membrane of the cells very evident, and transparent.* Cells *in the young filaments scarcely so long as broad, but their length exceeds their breadth in those which have conjugated; round the interior of the cells five or six loose spiral tubes may be faintly discerned; these contain the reproductive globules which are large, and distinct, with a dark central nucleus.* Sporangia *oval sometimes almost circular, and flattened, lying in inflated cells, the cavity of which they do not fill.*

Hassall, in Annals of Nat. Hist. vol. x. p. 37.

Hab. Essex, Hertfordshire, and in several places in Middlesex; abundant: *A. H. H.* In the pond between Ramslye Rocks and Broadwater Forest, and on Henfield Common: *Mr. Jenner.*

This well-marked species is readily distinguished from all others by the size of its filaments, the sporangia almost circular, and the inflated form of the cells. There is not a more distinct or attractive species in the genus.

7. Zygnema neglectum *Hass.*

Plate XXIII. Figs. 1, 2.

Char. Filaments *of less diameter than those of Z. nitidum.* Cells *rather longer than broad.* Spires *distinct, serrated.* Granules *large.* Sporangia *oval, in some specimens, occasioning a slight inflation of the cells in which they are lodged.*

Hassall, in Annals of Nat. Hist. vol. x. p. 37.

Hab. Neighbourhood of Cheshunt and other places; common: *A. H H.* Vicinity of Tunbridge Wells and in Kent: *Mr. Jenner.*

This species has doubtless usually been confounded with

Z. nitidum, of which the filaments are larger; the spires too, are generally but three in number, and the sporangia are less acutely oval, frequently also producing an inflation of the cells in which they are lodged.

8. Zygnema curvatum *Ag.*

Plate XXVI. Figs. 1, 2.

Char. Filaments *nearly equal in diameter to those of Z. neglectum.* Conjugation *angular.* Cells *three or four times as long as broad, coalescing without the intervention of transverse tubes.* Spires *about four in number, faintly indicated.* Sporangia *oval.*

Z. curvatum Ag. *Conf. stritica*, Eng. Bot. t. 2463. Harvey, Hook. Br. Fl. p. 362., also in Manual. *Mougeotia stritica* Kütz. Alg. Dw. *Sirogonium striticum* Kütz. Phyc. Generalis, p. 278.

Hab. Ditches in Henfield Level, Sussex, and pools on Chy-an Hâl Moor, near Penzance: *Mr. Borrer.* Cheshunt: *A. H. H.*

This species is remarkable for the direct conjugation of the cells, they uniting with each other without the intervention of tubes of communication, and it is the only species of the genus which does so. By this junction of the cells with each other, the filaments are bent at angles. The direct union of the cells and angular flection of the filaments of this species have induced Kützing to form a new genus for its reception under the name of *Sirogonium*. *Z. curvatum* seems in some measure to unite the genera *Zygnema* and *Mougeotia*, that it is nothing more than a *Zygnema*, however, is proved by the endochrome being disposed in a spiral order.

9. Zygnema pellucidum *Hass.*

Plate XXV. Figs. 1, 2.

Char. Filaments *of rather less diameter than those of Z. curvatum, mucous, almost transparent.* Conjugation *parallel.* Cells *six or seven times as long as broad.* Spires *indistinct,*

usually four in number. Sporangia *circular, lodged in cells, which are considerably enlarged for their accommodation.*

Z. pellucidum Hassall, in Ann. Nat. Hist. vol. x. p. 37.

Hab. Cheshunt: *A. H. H.*

This is a very curious and beautiful species, and one by no means common. I have only once been so fortunate as to meet with it in a state of reproduction, in which condition it is not possible to confound it with any other described species.

10. Zygnema rivulare *Hass.*

Plate XXVII. Figs. 1, 2.

Char. Filaments *seven or eight inches in length, usually attached, and in diameter about equal to those of Z. pellucidum.* Cells *varying in length from four to eight times their diameter.* Spires *serrated, three or four in number.* Granules *large.*

Z. rivulare Hassall, in Annals of Nat. Hist. vol. x. p. 38. Dill. t. 4. A. B.

Hab. In the Barge, New, and Lea rivers, near Cheshunt, abundant: *A. H. H.* Cader Idris: *Mr. Ralfs.*

This is a very distinct species, and certainly not the *Conjugata adnata* of Vaucher, the filaments of which equal nearly those of *Z. nitidum* in diameter. I have never been so fortunate as to find it in a state of reproduction. It would not appear to be common, as I have not received it from any other of my correspondents save Mr. Ralfs.

b. Spires *two in number in each cell.*

11. Zygnema deciminum *Ag.*

Plate XXIII. Figs. 3, 4.

Char. Filaments *rather smaller than those of Z. neglectum.* Cells *twice or thrice as long as broad.* Spires *two, crossing each other.* Granules *large.* Sporangia *oval, obtuse, not producing inflation of the cells in which they are lodged.*

Conf. jugalis Dillw. t. 5.; and *C. nitida*, t. 4. f. A. B. *Z. deciminum* Harvey, l. c. p. 362.; also in Manual, p. 143.

Hab. Cheshunt and Epping Forest: *A. H. H.* In a pond between Ramslye Rocks and Broadwater Forest; Henfield Common; and in a pond at Hill Park, near Westerham, Kent: *Mr. Jenner.*

This is a very pretty species, and also very distinct, the crosses described by the spires at once serving to distinguish it from all others belonging to this division of the genus *Zygnema*. Filaments frequently almost black.

c. Spires *single.*

12. ZYGNEMA QUININUM *Ag.*

Plate XXVIII. Figs. 1, 2.

Char. Filaments *of rather larger diameter than those of Z. deceminum.* Cells *longer than broad.* Spire *performing about three revolutions in each.* Sporangia *acutely oval, not producing inflation of the cells in which they are lodged.*

Conferva porticalis Müller, Nova Comment. Petropolitana, pars 3. p. 90. *Conjugata porticalis* Vaucher, Hist. des Conf. pl. 5. fig. 1.; Dillw. t. 3. lower figure.

Hab. Everywhere common throughout Britain.

"This *conjugata*, already described and observed by Müller, is perhaps the most common of all those of the same family; its spires are formed of brilliant grains united by a thread or a tube. Müller compares them to porticos, since in a certain state of their developement they have the form of a semi-ellipse."—*Vaucher.* The specific name of *quininum* bestowed upon them by Agardh is intended to express as well as Müller's of *porticale*, which ought properly to have been retained on account of its priority, the form described by each turn of the spires.

13. ZYGNEMA VARIANS *Hass.*

Plate XXIX. Figs. 1, 2, 3, 4.

Char. Filaments *of somewhat less diameter than those of*

Zygnema quininum. Cells *usually twice as long as broad.* Sporangia *oval, and not usually producing any inflation of the receiving cell.*

Hab. Cheshunt and its vicinity: *A. H. H.* At Hawkhurst; in a pond in a cottage garden between Broomhill and Speldhurst; and by the road-side near Blackboy's toll gate: *Mr. Jenner.* Graham Castle: *Major Martin.*

"This common species was formerly (see 'Annals and Magazine of Natural History,' vol. x. p. 35.) passed over by me as a variety of *Z. quininum,* from which I am now perfectly satisfied that it is specifically distinct. When a number of cells unite in regular order with those of a neighbouring filament, no inflation of any of these occurs; but it frequently happens that several adjoining cells of a filament for some reason or other do not unite, although the remaining ones in that filament do; in which case, those which have not yoked themselves swell up, assuming a moniliform appearance, and at the same time frequently emit blind and irregular processes or prolongations, by which the cells manifest the strong tendency which they have to conjoin themselves, but which some cause, not evident, would appear to have frustrated. In some specimens, the number of inflated cells and blind processes is but small, while in others the elongated cells are more numerous than those which have united in the ordinary manner of the *Zygnemata.*" — *MS.*

14. Zygnema æstivum *Hass.*

Plate XXVIII. Figs. 3, 4.

Char. Filaments *of less diameter than those of Z. varians.* Cells *usually about four times as long as broad, but sometimes much longer, and occasionally shorter.* Sporangia *oval, not producing any inflation of the cell in which they are formed.*

Zygnema æstivum Hassall, in Ann. Nat. Hist. vol. xi. p. 433.

Hab. Cheshunt: *A. H. H.* Wadhurst; and Bury, near Arundel: *Mr. Jenner.*

This species is distinguished from the former by the smaller size of the filaments, greater length of the cells, and peculiar zigzag disposition of the spiral thread; it is not, however, a very strongly marked species.

15. Zygnema malformatum *Hass.*

Plate XXX. Figs. 1, 2.

Char. Filaments *nearly equal in diameter to those of Z. æstivum.* Cells *about twice as long as broad, in each of which a single spiral thread performs usually two revolutions.* Sporangia *acutely oval, lying obliquely in the cells, which are considerably distorted for their accommodation.*

Zygnema malformatum Hassall, in Annals of Nat. Hist. vol. x. p. 39.

Hab. Cheshunt: *A. H. H.* In a pond at Still Green, and in the watercourse by the road side, near the Blackboy's toll-gate: *Mr. Jenner.*

I hesitated at first to regard this species as distinct from *Z. commune;* I now, however, entertain no doubt of the fact. It is a very pretty species, and not uncommon. The form of the cells is very distinct from that of *Z. commune.*

16. Zygnema catenæforme *Hass.*

Plate XXX. Figs. 3, 4.

Char. Filaments *a little finer than those of Z. malformatum.* Cells *usually rather more than twice as long as broad.* Sporangia *largely inflating the cells in which they are contained, acutely oval.*

Z. catenæforme Hassall, in Ann. of Nat. Hist. vol. x. p. 39.

Hab. Cheshunt: *A. H. H.* Between Yapton and Walberton near Arundel: *Mr. Jenner.*

It is scarcely possible to distinguish the filaments of this

species from those of *Z. commune* before conjugation: after this has occurred, the difference in the length of the cells and the form of these is so obvious as not to leave any doubt of its being distinct from that species. To this species ought, I think, the *Zygnema brevissimum*, described by me in vol. x. p. 40. of the "Annals of Nat. Hist." to be referred. I am still not sure, however, but that it is distinct, yet fear to regard it as such. The cells in it are scarcely so long as broad; the sporangia broadly oval, sometimes almost circular, their long diameter being placed transversely in the cells, which are frequently highly inflated.

17. ZYGNEMA COMMUNE *Hass.*

Plate XXVIII. Figs. 5, 6.

Char. Filaments *about equal in diameter to those of Z. catenæforme.* Cells *usually three times as long as broad.* Sporangia *acutely oval, not occasioning any inflation of the cells in which they are formed.*

Zygnema commune Hassall, in Annals of Nat. Hist. vol. x. p. 39.; Dillw. t. 3. upper figure, in part?

Hab. Cheshunt: *A. H. H.* Framfield Common: *Mr. Jenner.* Parkind Quarry: *Major Martin.*

This is a very distinct and regular species.

18. ZYGNEMA GRACILE *Hass.*

Plate XXX. Figs. 5, 6.

Char. Filaments *of less diameter than those of Z. commune.* Cells *usually four times as long as broad, and inflated on the side which gives origin to the tubes of communication.* Sporangia *acutely oval, not rendering the cells at all ventricose.*

Hab. Wanstead Flats, Essex; Cheshunt: *A. H. H.*

Apparently a distinct species, known from *Z. commune* by the smaller size of the filaments and lateral enlargements of the cells.

19. Zygnema flavescens *Hass.*

Plate XXX. Figs. 9, 10.

Char. Filaments *of less diameter than those of Z. catenæforme.* Cells *usually four times as long as broad, and slightly inflated for the accommodation of the* sporangia, *which are oval.*

Hab. Hertford Heath; High Beech, Essex: *A. H. H.* Several places in Sussex and Kent: *Mr. Jenner.*

The only species with which this could be confounded are *Z. catenæforme* and *Z. parvum*, between which it is intermediate. It seems to prefer, like several other species of the genus, the boggy pools of heaths, &c., to roadside ponds and ditches.

20. Zygnema parvum *Hass.*

Plate XXX. Figs. 7, 8.

Char. Filaments *more slender than those of the preceding species.* Cells *rather more than four times as long as broad.* Sporangia *oval, generally producing a slight inflation of the cells in which they are formed.*

Zygnema parvum Hassall, in Ann. Nat. Hist. vol. x. p. 41.

Hab. Cheshunt: *A. H. H.* In a pond between Ramslye Rocks and Broadwater Forest: *Mr. Jenner.*

This is one of the smallest species of the genus; it is not uncommon.

** *Extremities of* cells *inverted.*

21. Zygnema Grevilleanum *Hass.*

Plate XXXI. Figs. 1, 2.

Char. Filaments *of rather less diameter than those of Z. curvatum.* Cells *usually six or seven times as long as broad, round the interior of each of which winds generally one and sometimes two spiral threads.* Sporangia *broadly*

oval, lying in cells which are considerably inflated for their accommodation.

Zygnema Grevilleanum, Annals and Mag. of Nat. Hist. vol. x. p. 38.

Hab. Cheshunt and its vicinity: *A. H. H.* Framfield: *Mr. Jenner.* Dolgelley: *Mr. Ralfs.* Turf Dyke, near Ardrossan: *Major Martin.*

"To this fine species I have assigned the name of Dr. Greville, author of the excellent 'Algæ Britannicæ,' as a slight mark of personal respect, as well as an acknowledgement of the eminent services rendered by that gentleman to natural history."

22. Zygnema inæquale *Hass.*

Plate XXXII. Figs. 1, 2.

Char. Filaments *of smaller diameter than those of Z. Grevilleanum.* Cells *about five times as long as broad, and enlarged on the side from which the tubes of communication arise.* Sporangia *oval.*

Hab. Cheshunt: *A. H. H.*

This is not a common species. I have no doubt but that it is distinct.

23. Zygnema subventricosum *Hass.*

Plate XXXII. Figs. 3, 4, and 5.

Char. Diameter of the filaments *about equal to those of Z. commune.* Cells *usually five or six times as long as broad.* Sporangia *oval, occasioning the cells in which they are placed to assume a ventricose form.*

Zygnema ventricosum Hassall, in Annals of Nat. Hist. vol. x. pp. 38, 39.

Hab. Cheshunt and its vicinity: *A. H. H.* Heathfield; in a pond near Boar's Head, Ramslye Rocks; and

Rackham, near Pulborough: *Mr. Jenner.* Dolgelley: *Mr. Ralfs.* Parkind: *Major Martin.*

This is a very distinct, as well as common species; that which I regard as a variety of it occurs at Wanstead Flats, Essex, in which the filaments are somewhat finer, the cells considerably longer, and the sporangia smaller. This may be distinct.

24. Zygnema longatum *Hass.*

Plate XXXI. Figs. 3, 4.

Char. Filaments *about equal in diameter to those of Z. subventricosum.* Cells *usually eight times as long as broad.* Sporangia *not producing any inflation of the cells, in which they are formed.*

Conferva punctalis Müller, Flor. Dan. pl. 1. no. 1. *Conjugata longata* Vaucher, Hist. des Conf. pp. 71, 72. plate 6. fig. 1.; Dillw. t. 3. upper figure in part? *Z. æquale* Hassall, in Annals of Nat. Hist. vol. x. p. 39.

Hab. Cheshunt, rare: *A. H. H.* In a pond between Pembury and Lamberhurst Quarter: *Mr. Jenner.*

I have but little doubt of the correctness of the synonymes quoted; the cells are never inflated. "Il n'y a rien de plus elegant et de plus gracieux au microscope que cette jolie conjuguée."— *Vaucher.*

25. Zygnema inflatum *Hass.*

Plate XXXII. Figs. 6, 7, and 8.

Char. Filaments *of much less diameter than those of Z. subventricosum.* Cells *usually four, five, or six times as long as broad.* Sporangia *elongated, and lodged in cells which become considerably inflated for their reception.*

Conjugata inflata Vaucher, Hist. des Conf. p. 68. plate 5. fig. 3. *Zygnema varians* Hassall, in Annals of Nat. Hist. vol. xi. p. 431.

Hab. Cheshunt and vicinity: *A. H. H.* Rusthall Common; between Sharp's Bridge and Piltdown Common; Henfield: *Mr. Jenner.* Turf Dyke, near Ardrossan: *Major Martin.*

I have now ascertained that the *Zygnema varians* described by me in the "Annals of Nat. Hist." vol. xi. p. 431., is the *Conjugata inflata* of Vaucher, a species which I have been long anxious to identify. I have recently met with what I shall describe as a variety of this species, but which may possibly be distinct. It is characterized as follows: —

var. *a.* — Filaments *of the same diameter as those of the species proper.* Cells *eight or ten times as long as broad, and enlarged on the side which gives origin to the tubes of communication.* Sporangia *oval, long.*

26. Zygnema tenuissimum *Hass.*

Plate XXXII. Figs. 9, 10.

Char. Filaments *more slender than those of Z. inflatum.* Cells *eight or nine times as long as broad.* Sporangia *producing a slight inflation of the receiving cells.*

Zygnema tenuissimum Hassall, in Annals of Nat. Hist. vol. x. p. 41.

Hab. Cheshunt: *A. H. H.* Belmonden, Hawkhurst: *Mr. Jenner.* Parkind: *Major Martin.*

This species bears a very close resemblance to the preceding, from which it is chiefly distinguished by its smaller size.

Second Subgenus. — Filaments *not conjugating.*

* Cells *not inverted.*

a. Spires *single.*

27. Zygnema rostratum *Hass.*

Plate XXXIII. Fig. 1.

Char. Filaments *of somewhat larger diameter than those of Zygnema nitidum.* Cells *from half to once as long as*

broad, spires numerous, granules small. Sporangia *broadly oval, sometimes almost circular, lying obliquely in the cells, which are not inflated.*

Z. rostratum Hassall, MSS.

Hab. Pond, near Hounslow: *A. H. H.*

A very fine species, the largest of all the non-conjugating *Zygnemata.* It is very rare, for I have only once encountered it.

28. Zygnema Woodsii *Hass.*

Plate XXXIII. Fig. 1.

Char. Filaments *of somewhat less diameter than those of Zygnema quininum.* Cells *usually about half or two-thirds as long as broad.* Sporangia *oval, lying obliquely in the* cells, *which are enlarged on that side from which the tubes of communication proceed.*

Z. Woodsii Hassall, MSS.

Hab. Cheshunt and neighbourhood: *A. H. H.* Several places in Sussex and Kent: *Mr. Jenner.*

On looking over Dillwyn's "Synopsis of British Confervæ," I was surprised to find under the head of *Conferva spiralis* the following notice of the species just characterized: —

"Since the Introduction was printed, a curious specimen of this species has been gathered by Mr. Horne of Clapham, and examined by Mr. Woods, who gives the following account of it. 'The plant is a pale dirty green, nearly without gloss, about the size of *C. spiralis;* when magnified the length of the joints is seen to be about equal to their width, or a little more, and the spiral tube is in most parts nearly obliterated; but the chief singularity of this plant is in the connecting processes, which are uniformly at the ends instead of as usual in the middle of the joints, and each of which appears to unite with the process of the next joint of the same filament. No indication of the conjugation of two filaments is to be observed; the dark globules appear only when the two joints are thus connected, and the adjacent one is invariably empty.'" — *Synopsis,* p. 60.

The above *Zygnema*, which Mr. Woods has so accurately described, is also the variety of *Z. quininum* (*C. spiralis*), referred to by me in the 10th vol. of the "Annals," p. 35. I have now, however, had numerous opportunities of examining it in all stages of its developement, and have no doubt about the propriety of separating it from that species from which it is distinguished by its finer filaments, and shorter cells, as well as by the manner in which the sporangia are formed; characters which are constant.

29. Zygnema alternatum *Hass.*

Plate XXXIII. Fig. 3.

Char. Filaments *considerably finer than those of Z. Woodsii.* Cells *usually two and a half times as long as broad.* Sporangia *oval, not producing any inflation of the receiving cell.*

Hab. Cheshunt: *A. H. H.*

I have seen this but once: it may possibly be but a variety of the preceding species, although I can scarcely suppose that it is so.

30. Zygnema abbreviatum *Hass.*

Plate XXXIV. Fig. 4.

Char. Filaments *about equal to those of Zygnema commune in size.* Cells *once, or once and a half as long as broad.* Sporangia *oval, small, not producing any inflation of the cells in which they are lodged.*

Hab. Cheshunt: *A. H. H.*

This also I have only once met with. It appears distinct, however.

31. Zygnema angulare *Hass.*

Plate XXXIV. Figs. 1, 2, 3.

Char. Filaments *at first straight, but at the period of repro-*

duction becoming angulated, the angles being situated at the junction of the cells and produced by the tubes of communication. Cells *usually three times as long as broad.* Sporangia *oval, producing considerable inflation of the receiving cell.*

Zygnema angulatum Hassall, in Annals of Nat. Hist. vol. x. p. 41.

Hab. High Beech, Essex; and Cheshunt: *A. H. H.* Mayfield, between Sharp's Bridge and Piltdown Common; Barcombe and Framfield: *Mr. Jenner.*

The angular disposition of the filaments at the period of reproduction is not peculiar to this species, the filaments of most other non-conjugating *Zygnemata* being also angular at that period. A variety of this species has occurred to me, having cells only once and a half, or twice as long as broad.

32. Zygnema malleolum *Hass.*

Plate XXXIV. Fig. 5.

Char. Filaments *of nearly the same diameter as those of Zygnema parvum.* Cells *usually about six times as long as broad.* Sporangia *producing considerable inflation of the cells.*

Hab. Cheshunt: *A. H. H.*

This would appear to be a distinct species, differing from the following in the much greater length of the cells. The empty cell taken in connection with the fruit-bearing cell resembles somewhat in outline a hammer.

33. Zygnema affine *Hass.*

Plate XXXIV. Fig. 6.

Char. Filaments *of nearly the same diameter as those of Zygnema parvum.* Cells *usually twice or twice and a half as long as broad.* Sporangia *oval, lodged in cells, which are considerably inflated.*

Hab. Cheshunt: *A. H. H.*

I have only once met with this. If a condition of any, it must be of the preceding species.

b. Sporangia *formed in every cell.*

34. ZYGNEMA MIRABILE *Hass.*

Plate XXXV. Figs. 1, 2, 3.

Char. Filaments *equal to those of Z. commune in diameter.* Cells *about six times as long as broad.* Sporangia *oval, at first much elongated, and finally producing a slight inflation of the cells.*

Z. mirabile Hassall, MSS.

Hab. Cheshunt and its vicinity: *A. H. H.* In the pond between Tunbridge Wells Common and the Hurst Wood; in a pond at Burwash: *Mr. Jenner.*

This remarkable *Zygnema* I have repeatedly met with in the state in which I have described it, and which I believe to be its perfect condition. Mr. Jenner states that he is convinced that the cells are united, but that the connecting tubes are so frail as usually to be destroyed before the specimen is examined. Mr. Jenner's observation, however, I feel assured applies not to *Z. mirabile,* but to some other species; for had the cells at any period been united, they would have been clearly indicated, even in the absence of the connecting tubes, by the occurrence of empty cells in number equal to those which contained sporangia. Now I have said that in this species all the cells contain sporangia.

** *Extremities of* cells *inverted.*

a. Spires *two.* ...

35. ZYGNEMA HASSALLII *Jenner.*

Plate XXXVI. Figs. 4, 5.

Char. Filaments *of nearly the same diameter as those of Zygnema Grevilleanum.* Cells *five or six times as long as broad.* Spires *two, laxly disposed, and crossing each*

other. Sporangia *oval, large, and producing a considerable inflation of the cells in which they are lodged.*

Zygnema Hassallii Jenner, in Flora of Tunbridge Wells, p. 182.

Hab. Cheshunt and Notting Hill: *A. H. H.* Sandhurst; near the rock at Washington; and at Hellingly: *Mr. Jenner.*

Mr. Jenner has done me the honour to assign my name to the above species, which is one of the finest and most distinct of the *Zygnemata.* I encountered it several times during the spring and summer of 1842, but not having then met with it in a state of reproduction, I regarded the filaments as those of *Z. Grevilleanum,* which, however, are usually furnished but with a single spire, and in which the form of the conjugated cells is so different.

b. Spire *single.*

36. Zygnema quadratum *Hass.*

Plate XXXVII. Figs. 1, 2.

Char. Filaments *of rather less diameter than those of Zygnema Hassallii.* Cells *usually seven or eight times as long as broad.* Sporangia *oval, large, and much elongated, contained within quadrangular enlargements of the cells.* Tubes *of communication prominent.*

Zygnema quadratum Hassall, in Annals of Nat. Hist. vol. x. p. 41.

Hab. High Beech; Epping Forest; Cheshunt; and other places: *A. H. H.* Pond at Ramslye: *Mr. Jenner.*

This is one of the most distinct as well as curious of the non-conjugating *Zygnemata.* It is by no means uncommon.

37. Zygnema intermedium *Hass.*

Plate XXXVII. Fig. 3.

Char. Filaments *of rather less diameter than those of Z. qua-*

dratum. Cells *about five times as long as broad.* Sporangia *oval, and producing a slight inflation of the cells.*

Zygnema intermedium Hassall, in Annals of Nat. Hist. vol. x. p. 41.

Hab. High Beech; Cheshunt: *A. H. H.* Pond at Ramslye; water-course by the road side at Wadhurst; and in a wet place in Tunbridge Wells Common: *Mr. Jenner.*

This very distinct species might be readily mistaken for *Zygnema angulatum,* from which, however, it is at once distinguished by the inverted cells; which cells also are longer.

38. Zygnema diductum *Hass.*

Plate XXXVII. Fig. 4.

Char. Filaments *about equal in diameter to those of Z. intermedium.* Cells *eight or ten times as long as broad.* Sporangia *oval, producing very considerable inflation of the cells in which they are lodged.*

Hab. Cheshunt: *A. H. H.*

There is but little doubt of the distinctness of this species.

39. Zygnema vesicatum *Hass.*

Plate XXXVII. Fig. 5.

Char. Filaments *about equal in diameter to those of the preceding species, Z. diductum.* Cells *usually three times as long as broad.* Sporangia *oval, producing a very considerable inflation of the cells in which they are lodged.*

The chief difference between this and the following species consists in the more considerable size of the filaments.

40. Zygnema Jenneri *Hass.*

Plate XXXVII. Figs. 6. and 9.

Char. Filaments *of less diameter than those of Z. vesicatum.* Cells *usually three or four times as long as broad.* Spo-

rangia *oval, lodged in cells, which are considerably inflated.*

Hab. In a wet spot by the road side between Dudsland toll-gate and the Hall Farm, Mayfield; in the pond at Ramslye; in the watercourse by the road side near Mark Cross, &c.: *Mr. Jenner.* Cheshunt: *A. H. H.*

To this species, which is certainly a distinct one, I have assigned the name of Mr. Jenner, whose zeal and acuteness in the cultivation of a knowledge of the freshwater *Algæ*, as well as in the pursuit of other departments of Natural History, are so eminent. I could have wished that it had been more worthy to have borne his name; it has one advantage, however, over some others, which is this, that it is an abundant species.

41. Zygnema dubium *Hass.*

Plate XXXVII. Fig. 7.

Char. Filaments *rather more slender than those of Z. Jenneri.* Cells *five or six times as long as broad.* Sporangia *oval, long, placed in cells, which are inflated for their reception.*

Hab. Between Sidley Green and Ninfield, near Battle: *Mr. Jenner.* Near Wormly West End, Hertfordshire: *A. H. H.*

This may be but a variety of *Zygnema Jenneri.*

42. Zygnema minimum *Hass.*

Plate XXXVII. Fig. 8.

Char. Filaments *as slender as those of Z. tenuissimum.* Cells *many times as long as broad.* Sporangia *oval, lodged in much inflated cells.*

Hab. Cheshunt: *A. H. H.*

This possibly may not be distinct, but prove eventually to be the unconjugated state of *Z. tenuissimum.*

11. TYNDARIDEA *Bory.*

Char. Endochrome *disposed in the cells in a star-like form, the stellate masses being double in each cell.* Sporangia *usually circular, sometimes lodged in the cells, and occasionally in the connecting tubes.*

Derivation. Tyndaridæ, the constellation so called of Castor and Pollux; in allusion to the *twin star-like* masses contained in each joint.

Stellulina Link, Handb. iii. 261. *Agardhia* Gray. *Globulina* Link, in Hor. Physic. 5. *Lucernaria* Rouss. et Desv., Jour. Bot. i. 143. *Tyndarideæ et Ledæ species* Bory, in Dict. Class. *Conjugatæ, sect.* 11. Vauch. pl. 6, 7.

The species of the genus *Tyndaridea* are distinguished by the arrangement of the endochrome, which is in star-like masses, two of which are contained in each cell, connected usually by a band or tube. Concerning the nature of these bodies, numerous conjectures have been hazarded. It has been supposed that the one represented the male and the other the female, the sporangia resulting from their union: this conjecture, however, does not seem probable. This form, as well as the beautifully spiral arrangement of the endochrome, in the genus *Zygnema*, has doubtless been impressed upon these plants by the Deity, in order that they might appear the more attractive and more wonderful in the eyes of man.

The sporangia are usually circular, and lodged either in the cells themselves, or in the transverse tubes. By this difference in the situation of the sporangia, the genus admits of a natural division into two subgenera.

First Subgenus. — Sporangia *placed in the cells of one or other filament.*

1. TYNDARIDEA CRUCIATA *Hass.*

Plate XXXVIII. Fig. 1.

Char. Filaments *of considerable size.* Cells *once or once and a half as long as broad, at first densely filled with en-*

dochrome, which near the period of conjugation exhibits a somewhat stellate arrangement. Sporangia *circular, not producing any material change in the primary form of the cell.*

Conjugata cruciata Vaucher, Hist. des Conf. pl. vi. fig. 4.; pl. vii. fig. 2. p. 77.

Hab. Cheshunt: *A. H. H.*

I have but little doubt that this is the *Conjugata cruciata* of Vaucher. It is the finest of all the *Tyndarideæ* I have met with. It is not common: and I have only once obtained it with the sporangia formed.

2. Tyndaridea anomala *Ralfs.*

Plate XXXVIII. Figs. 2, 3.

Char. Filaments *smaller than those of T. cruciata.* Cells *in the young state usually about as long as broad, densely filled with endochrome, and invested with a broad and very apparent mucous sheath; in a more advanced condition the threads become narrower, the sheath smaller, and the endochrome more scattered, and sometimes even stellated; finally, the* sporangia *are formed, which are circular, and protrude slightly into the tubes of communication of the filaments.*

T. anomala Ralfs, MSS.

Hab. Penzance and Dolgelly: *Mr. Ralfs.* High Beech: *A. H. H.* In a boggy spot near Cross in Hand, opposite to where the road branches to Hailsham; Barcombe, in Sussex, and Weston Bogs, near Southampton: *Mr. Jenner.*

This remarkable and somewhat anomalous species was first discovered by Mr. Ralfs, who submitted it to the examination of several friends. For a long time, however, doubts were entertained by many as to whether it really was a *Tyndaridea* or not; doubts which I myself, in common with others, for a period entertained, but which I was happily enabled to

terminate by the discovery of a specimen in which perfect sporangia were formed. The filaments, when dried on paper, exhibit less gloss than the other species of the genus, and the endochrome contracts but little. When the sporangia are formed, but little difference can be detected between its filaments and those of the following species. Where the species does occur, it is ordinarily very abundant, destroying most other *Confervæ* with which it is in contact, by its more vigorous growth. The highly developed mucous sheath, which is so characteristic of the species, frequently presents waived and irregular margins.

3. Tyndaridea lutescens *Hass.*

Plate XXXVIII. Fig. 4.

Char. Filaments *of nearly the same diameter as those of the preceding species.* Cells *at first scarcely so long as broad, and filled with endochrome; subsequently they become longer than broad; and then the endochrome presents a partial division, each division being somewhat stelliform.* Sporangia *circular.*

T. cruciata Harv. in Manual, p. 141.

Hab. Cheshunt and its vicinity: *A. H. H.*

This is the species which until lately I have regarded as the *Conjugata cruciata* of Vaucher, to which in all, save size, it bears considerable resemblance. It appears to be the commonest species of the genus; but I am not able to refer it to any of Vaucher's species. *Tyndaridea abbreviata*, Annals of Nat. Hist., vol. x. p. 43, I am now inclined to think is but this species with cells shorter than ordinary.

4. Tyndaridea bicornis *Hass.*

Plate XXXVIII. Fig. 5.

Char. Filaments *more slender than those of the preceding species.* Endochrome *divided into two masses, which are united by a narrow band in the centre, each mass presenting two points or horns on its distant extremity.* Sporangia

circular, contained within the cells. Cells *usually rather more than twice as long as broad.*

Tyndaridea bicornis, Annals of Nat. Hist. vol. x. p. 43.

Hab. Cheshunt and other places: *A. H. H.*

This species is by no means uncommon, and is certainly distinct. A species described in the 10th vol. of the Annals of Nat. Hist. under the name of *T. interposita,* ought, I think, to be regarded as a variety of the species. Fig. 8. plate XXXVIII. may perhaps represent a species distinct from *T. bicornis.* I have more than once met with it just as represented in the figure.

5. T. INSIGNIS *Hass.*

Plate XXXVIII. Figs. 6, 7.

Char. Filaments *rather smaller than those of T. bicornis.* Cells *twice as long as broad, and frequently curiously distorted, that side of them which either has or is about to unite itself with another, becoming remarkably protuberant.* Sporangia *circular, and partly lodged in the transverse tubes.*

Hab. High Beech, Wanstead, and other places: *A. H. H.* Rusthall Common; in a pool by the road-side between Cross in Hand and Heathfield; pond near Five Ashes, Mayfield; on Waterdown Forest; Greatham and Storrington Commons: *Mr. Jenner.*

This species, which sometimes presents an appearance so remarkable, was first sent me by Mr. Jenner. It is by no means uncommon, and I think certainly distinct from all others with which I am acquainted.

6. TYNDARIDEA STAGNALIS *Hass.*

Plate XXXVIII. Fig. 9.

Char. Filaments *more slender than those of T. insignis.* Cells *about two and a half times as long as broad.* Sporangia

circular, extending into a portion of the connecting tubes. *T. stagnalis.*

Hassall, in Annals of Nat. Hist. vol. x. p. 42.

Hab. Abundant on Hertford Heath and other places in the counties of Hertfordshire and Essex: *A. H. H.* Rusthall Common; Waterdown Forest, and near Cross in Hand.

This is a distinct and common species. Fig. 10. plate XXXVIII. may possibly be distinct from this.

Second subgenus. — Sporangia *lodged in the transverse tubes.*

7. TYNDARIDEA IMMERSA *Hass.*

Plate XXXIX. Fig. 3.

Char. Filaments *of considerable diameter.* Cells *about once and a half or twice as long as broad.* Endochrome *distinctly stellate.* Sporangia *large, circular, and partly immersed in the cells.*

Tyndaridea conspicua, Annals of Nat. Hist. vol. xii. p. 187. pl. 7. fig. 17.

Hab. Wimbledon Common: *A. H. H.*

"This species bears considerable resemblance to Vaucher's figure of *T. pectinata.* I do not think, however, that it is that species, for I presume that Vaucher employed the same magnifying power to all his figures; in which case the filaments of *T. pectinata* would be almost equal in diameter to those of *Z. quininum,* and consequently nearly as large again as those of the present species."—*Annals.*

8. TYNDARIDEA CONSPICUA *Hass.*

Plate XXXIX. Figs. 1, 2.

Char. Filaments *rather smaller than those of the preceding species.* Cells *usually twice, or twice and a half as long as*

broad. Sporangia *usually spherical, but sometimes oval, and entirely confined to the transverse tubes.*

Tyndaridea immersa, Annals of Nat. Hist. vol. xii. p. 188. pl. 7. fig. 19.

Hab. Wimbledon Common: *A. H. H.*

A very rare species. I have seen it but once.

9. Tyndaridea decussata *Hass.*

Plate XXXIX. Fig. 6.

Char. Filaments *of less diameter than those of the preceding species.* Cells *usually two and a half times as long as broad.* Sporangia *circular, and a portion of them immersed either in one or other, or both cells.*

T. decussata Hassall, in Annals and Mag. of Nat. Hist. vol. xii. p. 188. pl. 7. fig. 18.

The species described by Vaucher, under the head of *Conjugata decussata,* would appear to be referrible to the next genus, and not to *Tyndaridea.*

10. Tyndaridea Ralfsii *Hass.*

Plate XXXIX. Figs. 4, 5.

Char. Filaments *of less size than those of T. immersa.* Cells *usually four times as long as broad.* Sporangia *elliptical, their long diameter corresponding with the length of the tube.*

Hab. Penzance: *Mr. Ralfs.* Near Cross in Hand, opposite to where the road branches to Hailsham, and on Piltdown Common.

T. Ralfsii Hassall, in Annals of Nat. Hist. vol. xii. p. 188. pl. 7. fig. 20.

"There is not a more beautiful or elegant species than this in the genus, and I have much satisfaction in dedicating it to Mr. Ralfs, its first finder, and a gentleman by whom

our knowledge of the *Algæ* has been so considerably augmented." — *Annals.*

12. MESOCARPUS *Hassall.*

Char. Cells *filled at first with endochrome, which subsequently contracts, and assumes an irregularly spiral form.* Sporangia *either circular or oval, and lodged in the transverse tubes.*

Derivation. From μεσος, middle, and καρπος, fruit.

Sphærocarpus Hassall, in Annals of Nat. Hist. vol. xi. p. 185. pl. 7. fig. 7. &c.

The genus *Mesocarpus,* for which I first proposed the name of *Sphærocarpus,* to designate the position of the sporangia, and which I now find to be preoccupied, differs from the two genera already described in not having the endochrome arranged in any definite and figured form. When the filaments are young, the endochrome occupies the entire cavity of each cell; as they grow older, however, spaces are left at the extremities of the cells; and finally the endochrome frequently contracts itself into a mere thread, irregularly twisted. The sporangia are never placed in the cells, as in all the species of the genus *Zygnema,* and in very many *Tyndarideæ,* but invariably in the transverse tubes of communication which become dilated for their accommodation. The species of this genus live in water, less pure than the *Zygnemata* and *Tyndarideæ,* being mostly found in boggy and ancient ponds, on commons, &c.; and on this account they are rarely so brightly coloured as are the species of those genera.

1. MESOCARPUS SCALARIS *Hass.*

Plate XLII. Fig. 1.

Char. Filaments *exceeding somewhat in diameter those of Mougeotia genuflexa.* Cells *about four times as long as broad.* Sporangia *oval, their long diameter being placed in the direction of the diameter of the cells.*

var. β. — Sporangia *circular.*

Mougeotia scalaris Hassall, in Annals and Mag. of Nat. Hist. vol. x. p. 45. pl. 7. fig. 7. *Zygnema ordinarium?* Berkeley's Gleanings. *Sphærocarpus scalaris var.*, Annals of Nat. Hist. vol. xii. p. 186. pl. 7. fig. 8.

Hab. England; common. var. β, Crowborough Warren: *Mr. Jenner.*

This is one of the commonest as well as most distinct species of the genus. I have encountered it repeatedly myself, and have also received it from Mr. Jenner. *Z. ordinarium* Berkeley is quoted as a synonyme with considerable doubt; but if that species be not the one above described, I am at a loss to which of the other species of the genus described in this paper it ought to be referred. The filaments in *Mesocarpus scalaris,* as well as in the majority of the other species of genus, are of a yellowish green, owing to the greater impurity of the water in which they dwelt.

Plate XLII. fig. 2. represents what I shall here describe as a variety of this species. The filaments are of the same diameter, but the sporangia, instead of being oval, are spherical. It is very probable that this is really a distinct species; but having seen it but once, I hesitate so to regard it.

2. Mesocarpus intricatus *Hass.*

Plate XLIII. Fig. 1.

Char. Filaments *smaller than those of M. scalaris.* Cells *five or six times as long as broad.* Sporangia *oval, rather larger than those of M. scalaris, their long diameters being placed in the direction of the width of the cells.*

Sphærocarpus intricatus, Annals of Nat. Hist. vol. xii. p. 186. plate 7. fig. 9.

Hab. Broadwater Forest: *Mr. Jenner.*

The only differences to be detected between this and *M. scalaris* are, the smaller diameter of the filaments, and

greater size of the sporangia; but these are, I think, of a sufficiently well marked character to justify its being ranked as a distinct species. It has only as yet been found by that indefatigable observer Mr. Jenner.

3. Mesocarpus recurvus *Hass.*

Plate XLIII. Fig. 2.

Char. Filaments *smaller than those of M. intricatus.* Cells *six or seven times as long as broad.* Sporangia *circular.*

Sphærocarpus recurvus Hassall, in Annals of Nat. Hist. vol. xii. p. 186. plate 7. fig. 10.

Hab. Penzance: *Mr. Ralfs.* Rackham Common: *Mr. Jenner.*

"This species I first received from Mr. Ralfs, and some two or three weeks afterwards it was sent me by Mr. Jenner. I regard, it however, as the species figured by Dillwyn (Supplement, plate C.), as *M. genuflexa* in a state of reproduction." — *Annals.*

4. Mesocarpus depressus *Hass.*

Plate XLIV. Fig. 1.

Char. Filaments *rather larger than those of Mesocarpus recurvus.* Cells *six or seven times as long as broad.* Sporangia *oval, small, their long diameter being placed in the direction of the length of the cells.*

Sphærocarpus depressus Hassall, in Annals of Nat. Hist. vol. xii. p. 186. plate 7. fig. 11.

Hab. In a boggy spot near Cross in Hand, opposite to where the road branches to Hailsham: *Mr. Jenner.* Penzance: *Mr. Ralfs.*

"There can be no doubt of the distinctness of this species, which was procured by Mr. Jenner, some weeks before it was found and transmitted me by Mr. Ralfs." — *Annals.*

5. MESOCARPUS NUMMULOIDES *Hass.*

Plate XLV. Fig. 1.

Char. Filaments *of rather larger size than those of Mesocarpus recurvus.* Cells *about six times as long as broad, not usually recurved.* Sporangia *circular, and smaller than those of M. recurvus.*

Sphærocarpus nummuloides Hassall, in Annals of Nat. Hist. vol. xii. p. 187. plate 7. fig. 12.

Hab. Hertford Heath: *A. H. H.*

This species approaches very closely to the following.

6. MESOCARPUS PARVULUS *Hass.*

Plate XLV. Figs. 2, 3.

Char. Filaments *much shorter than those of Mesocarpus nummuloides.* Cells *usually six times as long as broad.* Sporangia *circular, small.*

Mougeotia parvula Hassall, in Annals of Nat. Hist. vol. xi. p. 434.; *Sphærocarpus parvulus* Hassall, Annals, vol. xii. p. 187. plate 7. figs. 13, 14.

Hab. Hertford Heath, Epping, &c.: *A. H. H.* Near Cross in Hand and Waterdown Forest: *Mr. Jenner.*

The larger figure of the two may represent a distinct species.

7. MESOCARPUS OVALIS *Hass.*

Plate XLIV. Fig. 2.

Char. Filaments *about equal in size to those of Mesocarpus parvulus.* Cells *ten or twelve times as long as broad.* Sporangia *slightly elliptical, their long diameter being placed in the direction of the length of the cells.*

Sphærocarpus ovalis Hassall, in Annals of Nat. Hist. vol. xii. p. 189. plate 7. fig. 15.

Hab. Hertford Heath: *A. H. H.* Penzance: *Mr. Ralfs.*

"The sporangia, though elliptical, are not nearly so much so as those of *M. depressus*, and the filaments not one half so large." — *Annals.*

8. Mesocarpus angustus *Hass.*

Plate XLV. Fig. 4.

Char. Filaments *very slender.* Cells *many times longer than broad.* Sporangia *circular, very large in comparison with the size of the filaments.*

Sphærocarpus angustus Hassall, in Annals of Nat. Hist. vol. xii. p. 187. plate 7. fig. 16.

Hab. Penzance: *Mr. Ralfs.*

"This is a very distinct species, and for its discovery we are indebted to Mr. Ralfs." — *Annals.*

Sporangia *formed without union of the filaments, or commingling of the contents of two cells.*

9. Mesocarpus notabilis *Hass.*

Plate XLVI. Fig. 2.

Char. Filaments *at first cylindrical, but subsequently becoming angulated, the angle of flexion being situated in the centre of each cell.* Cells *usually about eight or ten times as long as broad, but frequently longer.* Sporangia *non-symmetrical, a single one being placed in the angle formed in each of the cells.*

Mougeotia notabilis Hassall, in Ann. Nat. H. vol. x. p. 46.

Hab. Found in great abundance in some brick-fields near Notting Hill: *A. H. H.*

I am unwilling to create a new genus for the reception of this curious and anomalous production, and am induced to refer it to *Mesocarpus*, on the supposition that were the filaments in any case to conjoin, and sporangia to be formed, that these would present the characters of the genus, and be either spherical or oval.

13. MOUGEOTIA *Ag.*

Char. Filaments *coalescing usually without the intervention of transverse tubes; no transference of endochrome, and no formation of sporangia taking place.* Conjugation *angular.*

Named in honour of *M. J. B. Mougeot,* a German botanist.

The genus *Mougeotia* corresponds with *Mesocarpus,* save in the important fact that, although the filaments conjoin, there is no transference of endochrome, and consequently no formation of sporangia.

The following account of the genus *Mougeotia* was inserted in the "Annals and Magazine of Natural History:" —

"The real nature of the genus *Mougeotia* does not hitherto appear to have been at all understood, and consequently the definitions given of it up to the present time are either erroneous or incomplete.

"Vaucher thus defines the genus *Mougeotia:* — '*Conjugées à tube interieur.*' And Agardh, as follows: — '*Fila articulata reticulata conjuncta, granulis absque ordine dispositis, fructibus in angulis reticuli collocatis.*'

"The first of these definitions is imperfect, and the second inaccurate, inasmuch as it contains a reference to perfect fructification distinct from the granules or zoospores.

"The true and original species of the genus *Mougeotia* are all characterized by the singular fact, that sporangia, which Agardh calls the fruit, are never found in them as they are in all other species of the conjugating tribe of *Confervæ.* The filaments do indeed unite, but no transference of the contents of one cell into the interior of the other, and consequently no formation of sporangia ever take place.

"This remarkable circumstance in the history of the genus *Mougeotia,* resting as it does on long-continued and careful observation of the species composing it, does not admit of the smallest doubt; and although not absolutely stated as a fact, it is yet strongly implied by Vaucher in his description of *Mougeotia genuflexa,* in which the following observations occur:—

"'This *Conjugata* has not presented to me the round

globules of the other species of the same family; on the contrary, the green matter which it incloses has appeared to me to present nearly the same form, so that I know not how the grain is formed, nor in what way the developement in this species is brought about; only I have remarked distinctly three or four bright grains immersed in this green matter, and I have seen in the month of April the cells separate from each other and sink in the water, but I traced them no further. Nevertheless, I have difficulty in believing that the brilliant grains are not the germs.

"'Since writing this description I have seen the germination of this *Conjugata* elsewhere in a manner very different from all the others: the matter does not pass from one tube to another neighbouring tube, but each cell itself furnishes a single young plant, the interior tube which it was found to enclose becoming a young *Conjugata* which was entirely contained in the old tube, as it itself contains the plants which are afterwards to become developed; it issues by the extremity when it occupies the last cell, and by the sides when it is found in one of the central cells.'

"With respect to the observations of Vaucher in reference to the germination of the young *Conferva* while still within the parent cell, I would observe that I have never witnessed this singular developement, and can confidently assert that this is not the legitimate or normal mode of developement of the species of the genus *Mougeotia*, which is by zoospores, developed external to the cells, as in other *Confervæ*."

1. Mougeotia major *Hass.*

Plate XL. Fig. 1.

Char. Filaments *of considerable size.* Cells *usually five times as long as broad.*

Mougeotia major Hassall, in Annals of Nat. Hist. vol. x. p. 44.

Hab. Cheshunt: *A. H. H.*

Either this species and the following are subject to very

considerable variation, or else several species, really distinct, have been improperly referred to them. At one time, entertaining the latter opinion, I was induced to add three other species to the genus; but not finding, on subsequent examination, that these species were well established, I shall omit all mention of them in the present work.

2. Mougeotia genuflexa *Ag.*

Plate XL. Fig. 2.

Char. Filaments *of smaller diameter than those of M. major.* Cells *seven or eight times as long as broad.*

Müller, Acta Petropolitana, pars 3. p. 92. pl. 1. fig. 9. *Conjugata angulata* Vaucher, Hist. des Conf. p. 79. pl. 8. figs. 1, 2, 3, 4.

This interesting species is one of the commonest of the whole tribe of freshwater *Confervæ*, and there is scarce a ditch in which it may not be found at all seasons of the year The tubes remain connected for a very long time after conjugation, and this explains why it is that the species should so constantly be found united. For Vaucher's account of its reproduction see page 172.

14. ZYGOGONIUM *Kützing.*

Char. Filaments *of equal diameter, rarely branched.* Cells *seldom conjugating; transference of endochrome rare.* Sporangia *none.* Endochrome *at first filling the cavity of the cell.* Zoospores *scattered without order through the colouring matter.*

Derivation. From ζυγος, a yoke, and γωνια, an angle.

This genus seems to me to be well established. At first I felt disposed, on perceiving that the filaments of *C. ericetorum* were occasionally branched, to refer the species to the branched *Confervæ*, acknowledging, at the same time, that in many points it resembled the conjugating *Algæ*. Subsequently, on finding union to have taken place between some

of the filaments, I felt satisfied that its proper place was with the *Conjugateæ*, and referred it to *Mougeotia*. This reference did not, in all respects, seem satisfactory, for while the true species of *Mougeotia* are almost constantly found united, *C. ericetorum* is very rarely met with in that condition. So rarely, indeed, as to make it apparent that the species is reproduced independent of any union of the filaments. The habit of *C. ericetorum* was so different from that of the true *Mougeotia*, being more that of a *Scytonema*, that I had determined to place it in a genus by itself; a step which, on looking over Kützing's "Phycologia Generalis," I found to have been already taken. Kützing thus accurately defines the genus:—

"Trichomata simplicia vel subramosa, parenchymatica hologonimica, primum viridis, deinde purpurascens; cellulæ cartilagineæ, crispæ, interdum didymæ; spermata nunc in trabeculis, nunc lateralia, globosa."

1. Zygogonium ericetorum *Kütz.*

Plate XLI. Figs. 1, 2.

Char. Filaments *not unfrequently branched.* Cells *usually about twice as long as broad, rarely uniting, but frequently emitting elongated and irregular processes, which are usually to be regarded as rudimentary ramuli.* Endochrome *occasionally becoming effused, generally from one cell into an adjoining one in the same filament, but sometimes that from both cells passes into a space formed between the two utricles.*

C. ericetorum Harv. in Hook. Brit. Flora, also in Manual, p. 125.; E. Bot. t. 1553.; Grev. Crypt. t. 261. f. 1.

It has elsewhere been stated that I had been induced, from the detection of ramuli on some of the filaments, to consider *Conferva ericetorum* as referrible to the branched *Confervæ*. It would appear, however, on closer examination, that while it certainly, by the not unfrequent occurrence of ramuli, exhibits a degree of relation to those species, yet that its affinities with the conjugating tribe are sufficiently strong

to make it apparent that its proper station is with these, and not with the branched species.

When a communication is about to be set up between two cells in the same filament, the opposed extremities of those cells are first seen to become slightly inflated, to point somewhat and then burst, effusing their contents sometimes into a space which is formed gradually between the two cells, but at others the endochrome of one cell passes directly into the cavity of the other.

All the cells in a filament do not usually communicate with each other at the same time, but at distant intervals; and around those cells between which a communication is about to become established, the investing membrane is observed to be thickened considerably, pointing out to the observer those cells which either have, or are about to take on, the characters of reproduction.

At one time I thought that the branches which I have so often met with were spurious, and might have been formed in the same manner as they sometimes are in *M. genuflexa*, &c., viz. by the union of the extremities of certain filaments at right angles with the cells of other filaments; but this idea was dispelled by observing, that in the specimens in which the branches occurred most abundantly, no union of cells in the regular way was to be met with.

The colour no less than the condition of the endochrome varies considerably in this species. In some specimens the filaments are of a bright green, in which case they have always been found immersed in water; while in others, and more frequently, they are purple; of which colour they invariably are when found spreading over swampy heaths. Specimens of a beautiful green colour were recently sent me by Mr. Jenner and Mr. Ralfs, and these, for some time, puzzled me exceedingly.

I have no hesitation in referring to this species the *C. purpurascens* of Carmichael, and *C. alpina* Bory which is but an aquatic condition of the plant, and strongly suspect that *Conf. tortuosa* Dillw. (the *Zygnema littoreum* Lyngb., and *C. perreptans* Carm.) might be referred to it likewise.

15. STAUROCARPUS.

Char. Sporangium *either square or cruciform, and lodged in the transverse tubes.*

Derivation. From σταυρος, a cross, and καρπος, fruit.

" Certain square or cruciform species of conjugating *Confervæ* were doubtfully associated by Agardh with the genus *Mougeotia;* these species I learned long since had been separated from it by Mr. Shuttleworth under the appropriate generic appellation of *Staurocarpus.* Mr. Shuttleworth however did not, so far as I can learn, publish his opinion of the propriety of establishing for these curiously formed species a distinct genus, contenting himself with communicating his views to some of his correspondents, of whom I may name the following as being conversant with those views: — Mr. Borrer, the Rev. M. J. Berkeley, and Mr. Ralfs. Within these few days I have been informed by Mr. Berkeley that Kützing has proposed this genus under the term of *Staurospermum* in a sketch of a work on the *Algæ*, inserted in the first number of the new series of " Linnæa." No account of the genus is given by Kützing, but merely the name and an enumeration of species belonging to it. Mr. Shuttleworth's appellation I conceive to be much more appropriate and accurate than that of Kützing, and have therefore ventured to retain it; for the word *Staurocarpus* applies to the fructification generally, which is either square or cruciform, while *Staurospermum* appears to me to specify the reproductive granules or zoospores themselves with which each sporangium is filled, and which are more or less of a circular form." — *Hassall, in Annals of Nat. Hist.*

That Agardh entertained a very strong suspicion that the square-fruited species ought to be separated from the genus *Mougeotia,* will be apparent from the following observations: —

" Ceteræ species quoad fructum non satis cognitæ, et postea forsan separandæ, huc tantum ob habitum retentæ."

The genus *Staurocarpus* differs from *Mougeotia* in the facts of the transference of endochrome and formation of sporangia,

while from the genus *Mesocarpus*, hereafter to be described, it is separated by the form of the sporangium.

But one species of this genus is described by British writers. In a recent number of the "Annals" two others were added, and I have now the pleasure of describing three other species.

1. STAUROCARPUS GLUTINOSUS *Hass.*

Plate XLVII. Fig. 1.

Char. Filaments *of considerable diameter, highly mucous, bluish green.* Cells *six or seven times as long as broad, those being the longest which have conjugated.* Sporidium *quadrangular, formed entirely by the transverse tubes.* Sporangia, *when perfect, somewhat oval.*

Mougeotia glutinosa, Hassall, in Annals of Nat. Hist. vol. xxii. pl. 7. fig. 1.

Hab. Hertford Heath: *A. H. H.*

This is a very distinct and fine species, occurring abundantly in boggy pools on Hertford Heath. Not unfrequently a number of contiguous pairs of cells unite, forming arched loops or links, separated from each other by the square ovarium, which is the chief characteristic of the species.

2. STAUROCARPUS CŒRULESCENS *Hass.*

Plate XLVII. Fig. 2.

Char. Filaments *of less diameter than those of Staurocarpus glutinosus.* Cells *usually eight or ten times as long as broad.* Endochrome, *when recent, cœrulescent; when dried, of a purple hue.* Sporangia *cruciform, large, and filled with zoospores of a greenish colour.*

Staurocarpus capucinus Hassall, in Annals of Nat. Hist. vol. xii. p. 184.

Hab. Henfield: *Mr. Borrer.* Tunbridge Wells: *Mr. Jenner.* Penzance: *Mr. Ralfs.* High Beech, Essex: *A. H. H.*

The colour of the filaments in this, as in other species, would appear to be subject to considerable variety; in their youngest condition, the filaments are stated to be cœrulescent; in their more advanced state, they are purple, and invariably so when dried, exhibiting on paper, which they often stain, some degree of gloss.

The *Leda capucina* of Bory, *Mougeotia capucina* of Agardh, is probably identical with this species.

3. Staurocarpus quadratus *Hass.*

Plate XLVIII. Fig. 1.

Char. Filaments *of less diameter than those of the preceding species, bluish green.* Sporangia *quadrangular.*

Mougeotia quadrangulata Hassall, in Annals of Nat. Hist. vol. xii. p. 185. pl. vii. fig. 3.

Hab. Cheshunt, and various places in the neighbourhood: *A. H. H.* Ashdown Forest, and on Crawley Down, near Turner's Mill: *Mr. Jenner.*

There is no difficulty in distinguishing this from all other species hitherto recorded.

4. Staurocarpus virescens *Hass.*

Plate XLVIII. Fig. 2.

Char. Filaments *smaller than those of St. quadratus, usually of a grass green colour.* Cells *before conjugation about eight or ten times as long as broad, but after that period becoming much longer.* Sporangia *cruciform.*

Staurocarpus affinis Hassall, in Annals of Nat. Hist. vol. xii. p. 185. pl. vii. fig. 4.

Hab. Pool near Royden, Essex: *A. H. H.*

This species comes very near to *St. quadratus*, from which it is distinguished by its somewhat finer filaments, and cruciform sporangium, the sporangia in *St. quadratus* being square.

5. STAUROCARPUS GRACILIS *Hass.*

Plate XLIX. Fig. 1.

Char. Filaments *more slender than those of St. virescens, and usually of a green colour.* Cells *many times longer than broad.* Sporangia *cruciform.*

St. gracilis Hassall, in Annals of Nat. Hist. vol. xii. pl. vii. fig. 5.

Hab. Penzance: *Mr. Ralfs.* Waterdown Forest, Broadwater Forest, Fisher's Castle, Crowborough Warren: *Mr. Jenner.* High Beech, Hertford Heath, Wormley, West End, and Wanstead Flats, Essex: *A. H. H.*

This is an abundant species, and very distinct from any of the others. It was found by Mr. Ralfs, Mr. Jenner, and myself, within a few days of each other.

6. STAUROCARPUS GRACILLIMUS *Hass.*

Plate XLIX. Fig. 2.

Char. Filaments *more slender than those of St. gracilis, and usually of a green colour.* Cells *very many times as long as broad.* Sporangia *cruciform, and about one half the size of those of St. virescens.*

St. gracillimus Hassall, in Annals of Nat. Hist. vol. xii. p. 185. pl. 7. fig. 6.

Hab. Hertford Heath and High Beech: *A. H. H.* Rackham Bogs, Parham Park, near Storrington, and Ashdown Forests: *Mr. Jenner.*

This species I have myself met with several times, but did not at first recognize its distinctness, of which, however, I now entertain no doubt: and it was only on the receipt of a beautiful sketch from Mr. Jenner, accompanied by remarks, that I examined thoroughly into the matter, and satisfied myself of its entire distinctness.

Fam. IX. CYSTOSPERMEÆ.

Char. Filaments *simple, subulate, non-conjugating.* Cells *at first equal, subsequently here and there inflated or vesicular.* Sporangia *formed by the union and condensation of the endochrome of two contiguous cells of the same filament.*

The impression which I first entertained respecting the *Confervæ* contained in this family was, that it would be sufficient to regard them as constituting a new genus, referrible to the *Conjugateæ* already described: subsequent reflection and examination have, however, convinced me that they should hold a higher than a generic rank, and that the characters presented by them are sufficiently distinctive to entitle them to the rank of a separate family.

Their filaments are simple, slightly subulate, owing to the cells growing laterally, or in diameter as well as in longitude, usually attached, do not conjugate, are articulated or jointed, and terminate in lanceolate extremities: in their young condition the cells are uninflated; subsequently, however, certain ones swelled up, this inflation being occasioned by the transference into them of the contents of one of the adjoining cells, and in these inflated cells, ultimately are formed, large oval or circular bodies, similar to those of the *Conjugateæ*, both in appearance and nature, and which therefore I in like manner denominate sporangia.

In addition to these essential characters of this family, the *Cystospermeæ* are distinguished by other, though less obvious, not less important characteristics. The filaments are of a firmer texture than those of most other *Confervæ*, they possess comparatively but little flexibility, are not mucous, and consequently do not exhibit that glossy appearance presented by so many *Confervæ* when removed from the water, and which they retain when dried upon paper; in all which particulars they stand in marked opposition to that numerous and

important division of the freshwater *Confervæ*, the *Conjugateæ*, in the species of which the filaments are flexible, mucous, and shining in the highest degree: in them, too, the filaments never taper, but are always exactly cylindrical. Moreover, the articulations differ in the two groups: in the *Cystospermeæ* they are strongly marked, and when dried, become contracted and dark, while in the *Conjugateæ* they are faintly indicated; and in dried specimens are often with difficulty discoverable.

Such are the leading features of this interesting division of the *Confervæ*, and on a careful examination and estimation of the many points of difference here enumerated between them and the *Conjugateæ*, the tribe to which they most closely approximate, there can be no doubt, I apprehend, of the propriety of retaining them in a separate family.

The differences are too great to admit of their holding merely a generic rank. The naturalness of the different genera forming the preceding family may be readily perceived, these passing through certain species, the one into the other; and all being allied by certain resemblances: but how wide is the interval between any of these and the group of *Cystospermeæ!*

The sporangia in the different species of *Cystospermeæ* are produced in the same manner as in the non-conjugating *Zygnemata;* that is, by the concentration of the contents of two adjacent cells in the same filament, this being necessarily always accompanied by the inflation of the receiving cell, and the giving cell being constantly placed in communication with the narrow end of the ovate inflated cell.

In all the *Conjugateæ* the endochrome is seen to pass through tubes of connection between the cells, whether in different or in the same filaments: in these, however, no such passages exist, the contents of the cells escaping apparently through a rent occasioned by some agency in their extremities. The notice of this particular furnishes an additional distinctive character between the two groups: but others still remain, two of which may next be noticed.

The first of these relates to the presence of a peculiar and

regular annulation of the enveloping membrane of the cells, which would appear at a certain epoch to be intimately adherent to the tissue of the cells themselves.

"The genus of freshwater *Confervæ* which I have denominated in a previous article *Vesiculifera**, in addition to the characters indicated in the definition of it given therein, such as the attachment, attenuation and slight mucosity of the filaments of the species composing it, as well as the formation of true spores by the intermingling and union of the contents of two cells in the same filament, is particularly distinguished by the presence of a peculiar and regular annulation of the enveloping membrane of the cells, which would appear at a certain epoch to be intimately adherent to the tissue of the cells themselves." (Pl. XVII. figs. 7, 8.)

"This annular disposition of the sheath of the cells does not occupy its whole extent, but corresponds only to certain cells and determinate portions of those cells; the cells around which it is disposed being those in which the spores are destined to be formed, and the portion of these which it invests being the extremities through which no endochrome passes from the contiguous cells for the formation of the true spores, or rather perhaps sporangia.

"The number of annuli which correspond to each fructiferous cell varies according to the species, and is more considerable in the long-celled species; it would appear however to be never less than two, or more than eight or ten, to each cell.

"The use of this interesting structure is much more apparent than that of the provision already noticed as belonging to one section of the genus *Zygnema*, and admits of a most satisfactory explanation, it being manifestly designed to afford an outlet to the imprisoned spores, which it may be supposed to do in the following way. As soon as the species has reached its maturity and the spores have become perfected, the annuli, which are intimately united to the cells, contract, most probably from the arrest of growth and diminution of vitality

* This genus was first established by me in the "Annals and Magazine of Natural History," vol. x. p. 385.; it will be seen, however, that the views here expressed differ in many respects from those therein stated.

of the plant which occur towards the completion of the process of reproduction, drawing along with them, and thus rupturing, the slightly elastic membrane of the cells. (Pl. XVII. fig. 7.)

"Without some such beautiful and effectual provision, it will be evident, on reflection, that the spores would have to remain immured within their narrow cells for an indefinite length of time, even until, perhaps, their vitality had ceased and the cells had become their coffins; for occupying, as the spores do, but a portion of the space of the cells, and enveloped as they are in membranes, they can themselves, of course, exert no influence in producing the rupture of the walls of those cells.

"In all the *Confervæ* with which I am acquainted, some special means are provided for the escape of the spores or zoospores, their liberation never being left to the sole agency of decomposition of the tissue of these plants; thus, in the majority of the branched *Confervæ*, and in the species of the genus *Sphæroplea* as well as in many other *Confervæ*, their liberation is effected by the rupture of the cells in which they are contained, which rupture is occasioned by the developement of the zoospores while still inclosed within the cells; in *Conferva* (*Microspora*) *glomerata* a special aperture exists for the escape of the zoospores at the period of reproduction, situated at one side of the distal extremity of each cell; in the Conjugating tribe the zoospores pass out through the openings of the connecting tubes of the cells, which, when reproduction has been completed, separate from each other; and lastly, in the *Vesiculiferæ*, as has been shown, a more complicated provision exists for the egress of the spores and zoospores.

"Of all characters whereby the *Vesiculiferæ* may be distinguished from other *Confervæ*, that derived from the corrugation of the investing sheath is perhaps the most valuable, from the circumstance not merely of its being confined to the species of that genus, but from its constant presence in all stages of their developement; and not only is it interesting as being indicative of a *Vesiculifera*, but also as pointing out

those cells, even in the young and but little developed *Vesiculifera*, which are destined to carry the true spores when the species shall have arrived at the perfection of its life."

Meyen, by whom this interesting structure seems first to have been noticed, gives the following account of its characters in a species which he calls *Conferva rivularis*: —

"The annular structure appears worthy of notice, which the upper end of many of the joints of the *Conferva* represented exhibits. This appearance is altogether analogous to the annular structure observed in the horny coat of the *Campanulariæ*. In those polypi also this structure appears first at an advanced period of growth, as is the case with the *Conferva*, and indeed in very different species of articulated plants of this family. The formation commences with a thickening of the membrane; the constrictions then appear, which are not spiral, but run in horizontal rings one above the other. Sometimes it seems as if this ringed substance were an entirely new formation." — *Meyen, Pflanzen-physiologie*, vol. iii. p. 451.

The above is the entire of Meyen's account of this corrugated formation, which does not in all respects accord with my own observations. The structure is, amongst freshwater Algæ, confined to the species of the genus *Vesiculifera*.

"The purpose to which the annular disposition of the horny coat, of not merely the *Campanulariæ* but of most hydroid Zoophytes, is subservient, is probably that of rendering their polypidoms more flexible, and consequently less liable to injury from the agitation of the restless element in which they dwell." *

The second particular refers to the central cytoblast or reproductive vesicle, which, in the group of *Cystospermeæ*, is circular, whilst in one genus of the *Conjugateæ*, *Zygnema*, it is somewhat quadriform, and furnished with tubular offsets.

It is at once apparent, that the mode of reproduction just indicated, does not differ essentially from that first made known by Vaucher, with reference to the *Conjugateæ*, and

* See Annals of Nat. Hist.

especially in respect to those most interesting species which I have described as producing true sporangia, without union of the filaments.

This discovery of the identity of the mode of reproduction of the two families of *Confervæ* hitherto treated of, leads necessarily to some general, and not unimportant conclusions.

Thus, it furnishes satisfactory evidence of the intimate and general connection which exists between these two families, which include such a considerable proportion of the freshwater *Confervæ*, whereby much light is thrown upon the often canvassed and much disputed subject of the animality of the conjugating genera, for it proves, since in reality a conjugation takes place for the formation of all true sporangia, that both stand upon the same footing as regards their animal nature, a fact, which hitherto has never been suspected, the vegetable character of the *Cystospermeæ* having long been considered as established, and that if those species which exhibit the curious phenomenon of conjugation are really animal, so are all the true *Confervæ;* thus, if these should at any subsequent period be removed from the vegetable kingdom to the animal, so ought, as an inevitable consequence, all the other *Confervæ* which I have included in the group of *Cystospermeæ*.

But it appears to me that, from the fact disclosed of the union and concentration of the contents of *two* cells in so many *Confervæ*, no argument can be deduced either in favour of the sexuality or animality of the *Confervæ*, numerous species occurring, as already observed in the Introduction, in which this curious phenomenon is wholly wanting.

For my own part, I trouble myself but little with the disputes about the boundaries of the two great divisions of the organised world, which forcibly remind me of the search carried on by ancient philosophers, for days and years, after the much-desired, but imaginary philosopher's stone, endowed with such all-pervading influence, or the equally fruitless inquiry after perpetual motion, or any other of the wild chimeras to which the minds of men have from time to time been given. It is my belief, that no such rigid boundary exists;

for in living nature there are no abrupt unsightly chasms; all is uniformity, transition, design.

To the group *Cystospermeæ* are to be referred all the true *Confervæ;* but before admitting any species as such, it is necessary that it should undergo a rigorous examination; for we find placed among the *Confervæ* proper many species having no relation whatever with those near to which they are placed, but are referrible to some others of the genera belonging to the other divisions of the *Confervæ* already established. Thus *C. alpina, C. purpurescens, C. zonata, C. punctata, C. ericetorum, C. mucosa,* are placed by Agardh the elder and Harvey amongst the *Confervæ* properly so called. The first two, nevertheless, are *Conjugateæ, C. zonata* and *C. punctata Sphæropleæ,* and *C. mucosa* a *Desmidium.*

It may be thought by some, that instead of instituting a new generic name, it would have been better to have reserved for the species included under it the old appellation of *Conferva.* To the adoption of this course, two objections present themselves; the first is, that it appears unadvisable that the term *Conferva* should ever be employed merely in a generic sense—that a wider meaning ought to be extended to the word—that it should be employed in the same manner as the term *Zoophyte,* and made to embrace the filamentous division of the *Algæ;* and the second is, that there is no reason founded in right, why this term of Linnæus should be perpetuated in any other way than that suggested, he, and all who have hitherto employed it, having had no definite ideas respecting the exact nature of the productions which ought to be referred to it—*Algæ* widely differing in essentials having constantly been placed under it.

Five of the six species of *Prolifera* described by Vaucher are certainly to be referred to the genus *Vesiculifera,* the sixth *C. glomerata* is of an entirely different nature. So imperfectly and inaccurately, however, are those species described and delineated, that it is impossible to identify them with any degree of certainty. The following is Vaucher's account of the reproduction of the genus *Prolifera,* which, it

will be seen, is not in all respects inaccurate, though still, for the most part, very erroneous: —

"When the *Proliferæ* are ready to reproduce, cylindrical enlargements are seen to arise in the length of the filaments, which one would take for knots, if the plants were not articulated or chambered. These *bourrelets*, at first but little apparent, soon increase in size, and finally become covered with a pulverulent material, which is formed either by refuse matter which floats in the liquid, and which has been retained within the elevations, or of a material which is secreted by the *Confervæ*. When this powder has remained some time upon the enlarged part of the stem, a number of filaments are seen to issue from it, which form at first little rounded heads. Unfortunately this powder at the same time that it seems to favour the increase of the young *Confervæ* baffles greatly the observer. He is able to see but little of the first developement of the plant, and in consequence is not able to judge, whether it issues from the surface of the enlargement or from the centre: whichever it may be, the young filaments extend themselves round all the circumference, where they form as it were a tuft of hairs. Little by little their cells begin to be marked out; soon their tubes resemble in miniature those of the great *Proliferæ*. Lastly, they go and form elsewhere a new individual, like to that from which they took their birth: but I acknowledge," says Vaucher, "that I have not seen this separation, although I have no doubt but that it really takes place."

What Vaucher regards as the young proliferous offspring, are doubtless to be regarded as parasitic growths, to which the *Confervæ* are peculiarly liable, more especially when they are confined for a length of time in small vessels of water.

Two other species of this group have been referred by Meyen to a genus *Hempelia*, which he instituted for them, a genus even more erroneously defined than that of *Prolifera*, already noticed.

"HEMPELIA. — Thallus simplex, membranaceus, septatus, æqualis vel inæqualis. Fructus terminalis est, capsula sub-

pyriformis, apice regulariter vel irregulariter dehiscens, et sporas emittens. Sporæ globosæ, hyalinæ, massa grumoso-submucilaginosa infarctæ, utriculos implentes.

"*H. mirabilis.*—Filis inequalibus viridibus brevibus, septis semi-pellucidis; sporis e capsulis emissis ad fasciculos conjunctis; utriculis cylindricis diametro dupli-triplo longioribus, hinc inde ad globulos tumescentibus, qui, secreti ab aliis utriculis, ut animalcula infusoria, se movent et, rumpentes eorum membrana, sporas emittunt."

For the following translation of Meyen's remarks upon the above species I am indebted to Mr. Kippist, to whom I may take this opportunity of rendering my best thanks for the kindness and readiness with which that gentleman has always undertaken whatever could facilitate the progress of this work: —

"This plant is found in a water-tank of one of the warmest houses of the botanic garden at Bonn. I first observed it in the beginning of January of the present year (1827). It was at that time already in fruit, and during a period of three and a half months, during which I have observed it, it has continued quite in the same condition in which I at first found it.

"It is a constant character of this *Conferva*, that the fruit capsule appears at that end of the filament by which it is attached to the side wall of the water-tank, and from the great mass of spores scattered by the capsule, all the *Confervæ* which spring up at the same spot grow together into such a heap that their basis appears of an almost uniform black, from which the *Confervæ* project in a radiating manner. I have not yet succeeded in determining whether the threads have first attached themselves to the wall of the tank, after the formation of the capsule, or whether the last joint, by which they, as it were, take root on the wall, may have gradually assumed the form of a pear-shaped capsule, with an extended neck. Even if in this latter case the explanation of the structure of the capsule should present further difficulties, I might still be able to explain them. I have but very seldom been able to observe the streaming out from the

capsule of the masses of spores, which were surrounded by a bright green granular mucilaginous mass, and thus were held together in a ball. I have never been able to observe in the interior of this mass any peculiar motion of the spores, yet I have seen that during the discharge (*Ausströmen*) several seeds separated themselves from the principal mass, and then exhibited a high degree of voluntary motion, which often lasted a long time, and which still belonged to them when they had distinctly increased in length, apparently in order to produce new individuals: this occurrence I have not actually been able to observe in this species, but I hope that during this summer it will not escape me.

"The above-mentioned capsule is exhibited in very different forms in the accompanying tables; it ordinarily presents a pear-shaped figure, with a more or less elongated neck, which frequently expands into the form of a funnel; the breadth of the capsule is greater at the base than that of the next joint. The gradual developement of this organ, which I have not been able to observe here, will be given with the following species. It is however to be observed that the capsule, after the discharge of the spores, separates from the filament, and then presents the form which is to be seen in figures 8 and 9.

"The filaments are dissimilar, and, with advancing age, the dissimilarity increases, so that, at length, the elliptical form of an utriculus passes into a perfectly spherical one." I had the good fortune to observe how such a spherical utriculus separated itself, under my eyes, from the other tubes (*Schläuchen*), and, existing only for itself, moved, I might almost say voluntarily, with incredible swiftness in all directions. Figure 11. *a* and *b* show these detached spherical utriculi; and, whilst observing them, I succeeded, by blowing on the object-bearer, in hastening this separation, and then observed the free motion of the separated tube. With regard to the structure of this organ, it is to be observed, that it is usually as simple as that of the ordinary utriculus, whilst the spherical cell is closely filled with masses of spores. In one part, however, of the circumference of the sphere may be seen, upon close examination, a transparent portion, like an affixed

larger section of a smaller sphere, which, during motion, is always directed forwards, while the entire sphere continually revolves on its longer axis, and this with a wonderful rapidity. At length I observed the fine skin of the organ to burst, and with the discharge of the motionless spores, followed the *death of the animal life* (*der Tod des animalischen Lebens*) of this organ, and the plant appeared. It must also be observed, that the mass of spores, which is discharged from this sphere, is much more highly developed than that which escapes from the capsule, since in the former they are little more than vesicles, and scarcely present any thing of the grumous shiny mass, which in the latter is very evident.

"In figs. 12. and 13. are displayed similar organs of irregular form, whose origin it is very difficult to explain. If I had not observed the springing up of this organ, as well as its propagation (*Fortpflanzung*), of which I shall speak hereafter, one might suppose it to represent the seeds, which here appear to be a little more extended, and seated on the parent plant, to be about to shoot out into young *Confervæ*. This idea is, however, entirely false, since such a mode of growth occurs only in the inarticulate *Confervæ*, and therefore in *Vaucheria*. In conclusion, I must be allowed to assert that this species has hitherto never been observed, since the dark-green colour, the shortness of the filaments, and their lying one upon another, are very striking characters; yet we nowhere find them given."—*Meyen, Kritische Beiträge zum Studium der Süsswasser-Algen Flora*, No. 45., December, 1827.

Meyen's second example, *H. polymorpha*, seems to include more than one species belonging to different genera.

The genus *Hempelia* is false both in fact and philosophy. The capsule, upon which Meyen lays so much stress, is nothing more than the first developed cell of the *Conferva*, or transformed zoospore, and has nothing whatever to do with the reproduction of the species. To imagine that it has, is in the highest degree unphilosophical, for it is to attribute that function, which is indicative of the perfection of the life of an organic being, and which is the last for it to assume, to

the part of the plant first formed; it is to invert in fact the natural order of things

In the third volume of the "Mémoires du Museum," 1817, there is a paper by M. Leon le Clerk, on the genus *Prolifera*. In this paper Vaucher's error in reference to growth of the species by shoots is pointed out, and the formation of circular bodies or sporangia noticed. M. Leon le Clerk was not satisfied, however, that these bodies were formed by the union of the endochrome of two cells, as they doubtless usually are. "But it will be asked," he remarks, "what cause determines the formation of the green matter into the globule which we have described. To this question we frankly avow our ignorance. We can only give the assurance that this formation takes place without any kind of union with another filament, as we had at first suspected from analogy *to* the *Conjugateæ*. Perhaps, pre-occupied by the same analogy, one might be led to suppose that two neighbouring divisions of the same filament united their green matter to form the reproductive globule. This supposition vanishes however upon the slightest examination. The two divisions indeed bordering on that which contains the grain present often the green matter in its integrity, and if there be need for a fact still more decisive, it has occurred to us often to meet with not only two contiguous inflated cells, but three or four adjacent cells all equally in fructification."

These two facts, mentioned by M. Leon le Clerk, do not at all disprove the general rule, that the globules or sporangia are formed by the union and condensation of the endochrome of two cells. The correctness of the first statement is very questionable; it has never occurred to me to notice endochrome in the cells on both sides of the sporangium, and I am certain that where this body is perfectly formed the greater portion of the green matter of the cells on one side or other of it will invariably be found to have quitted that cell.

With regard to the second particular, viz. the occurrence of more than one sporangium in contiguous cells, this I think can scarcely be regarded as an exception to the rule, at least it admits of explanation. The occurrence of two contiguous

inflated cells occupied with sporangia or globules, is quite consistent with the idea of these bodies being formed by the contents of two cells, since each may be in contact on either side with an inflated cell. In the very rare instances in which three or four contiguous cells occur, I have never noticed a perfect globule in each of these, and even if such ever exist, each globule yet might be formed not indeed of the *entire* contents of two cells, but still of a *portion* of the green matter of two.

M. Leon le Clerk thus defines the genus *Prolifera*. "Filamentis loculatis simplicibus, materiâ viridi granulis fulgidis aspersâ totaliter repletis. *Singulo loculo*, fructificationis tempore, *propriis viribus* in *globulam suam efformante*. Isto globulo intense viridi ex loculo demisso novam plantam emittente."

This definition of M. Leon le Clerk is exceedingly faulty. It is not in each cell that the round globule is formed, but only in occasional cells, or at most in alternate cells; and the assertion that this globule really gives origin to a new plant, is by no means established. Even M. J. Decaisne, who has separated the *Conjugateæ* from the *Algæ zoosporæ* of Agardh, does not state that he has witnessed their developement, but infers this from the fact that the filaments of the *Conjugateæ*, whether young or old, in the same species, invariably present the same diameter, and thus, as he supposed, could not proceed from organs so minute as the zoospores.

M. Decaisne combats the idea of the disintegration of the sporangia of the *Conjugateæ* and *Vesiculiferæ* into zoospores, by the fact that their contents are at all times fluid. This argument is, however, by no means conclusive, the contents of the cells of the *Vesiculiferæ*, &c., are also generally fluid; but this fluid, when the proper period arrives, becomes fashioned into distinct organs or zoospores, and the same may be the case with the contents of the spores of the *Zygnemata*, as asserted by Agardh.

M. Decaisne also repudiates the idea of a double mode of reproduction; the spores he regards as the true and only reproductive bodies of those *Algæ* which possess them; but it

is perfectly certain the usual and most frequent method of reproduction of the *Vesiculiferæ* is by means of zoospores, and this fact, of which I have so perfectly assured myself, leads to adoption of one of the following views — either that the large, oval, or spherical bodies of the *Algæ*, comprised in M. Decaisne's class of zoospores, are not in any way connected with reproduction; a view which can scarcely be regarded as probable, and opposed to that entertained by M. Decaisne himself; or that they as well as the zoospores do perpetuate the species; in favour of which view the evidence can scarcely be pronounced sufficient to remove all doubt of its correctness.

Link has endeavoured to establish this genus under the name of *Œdogonium*, which has been adopted by Kützing, who thus imperfectly characterises it.

"Trichoma simplex, membranaceum, flaccidum. Cellulæ cœlogonimicæ, gonidia minutissima mobilia continentes. Spermatia solitaria globosa fusca, episperme duplici hyalino cincta, cellulis inclusa."

In this description no allusion is made to the mode of formation of the sporangia, and none to the ringed apparatus with which each fruit-bearing cell is provided.

Several other generic terms have been applied to certain species of the genus *Vesiculifera*, such as *Tiresias*, *Cadmus*, *Zoocarpa* *, &c. but all of them, so far as I can learn, are

* Respecting the genera *Œdogonium*, *Tiresias*, and *Zoocarpa*, I have obtained the following information: — In the "Dictionnaire Classique," vol. xii. p. 78., Bory thus remarks on the genus *Œdogonium*. "The genus proposed by Link under this name appears to be the same as that which Vaucher named *Prolifera*, for which we have adopted the name of *Vaucheria*. In the remarks on *Vaucheria*, Bory states that it was wrong of De Candolle to change the name of *Ectosperma*, which he proposes to restore, and to confer the name of Vaucher on the genus *Prolifera*, that appellation being founded in error: and Guilleman in the 16th volume, p. 268., of the same work, under the head of *Tiresias*, observes — 'Our co-labourer, Bory de St. Vincent, has established and described a new genus of the family of *Arthrodeæ* and of the tribe of *Zoocarpeæ*, in which he indicates as the principal species the *Conferva bipartita* of Dillwyn (a *Tyndaridea* ?). The characters of this genus have been explained in this Dictionary, vol. i. p. 597—1822.' Since that time the genus has been adopted by Fries, who has placed it amongst his *Hydrophytes* or *Algæ*;

founded upon a partial, imperfect, and often inaccurate knowledge, and therefore not admissible. If any of the older terms should be retained for the genus *Vesiculifera*, it should be by right of priority, — *Conferva*, for this genus hitherto has been made to embrace various species of *Vesiculifera*, as well as certainly a heterogeneous mass of other productions; but it seems to me that this genus ought to be abolished altogether, and that the term *Conferva* should be used in a more extended sense, and applied generally to any species of the confervoid *Algæ*, in the same manner as the word zoophyte is now used. Kützing, in his "Phycologia Generalis," confines the genus *Conferva* to certain species of *Sphæroplea*, and to the marine species of *Confervæ*, with simple filaments, such as *Conf. ærea* and its allies. Next to *Conferva*, *Prolifera*

and who observes that the *Zoocarpea* of Nees of Esenbeck, "Nov. Act. Nat. Cur." an. 1813, p. 517., is the same genus. The same author thinks that the greater part of the *Proliferæ* of Vaucher, also the *Œdogonium* of Link, ought to constitute part of the genus *Tiresias*. Of *Tiresias*, Bory gives the following description: 'Filaments cylindrical, the interior tube filled with green colouring matter, in which are developed hyaline corpuscles which separate from the filaments. This colouring matter ends by becoming agglomerated *in each cell* into a sphere or zoocarpe, of appearance similar to the gemmæ of the *Conjugatæ*, and inert up to the moment when rupturing the cell by its developement, and, putting itself in contact with the surrounding fluid, it commences to move itself in different directions, and finishes by swimming freely about, leaving all broken and transparent as water the tube which produced it.' The *Conferva bipartita* of Dillwyn is certainly a species of *Tiresias*, in the vegetable condition of which the *Cercaria podura* and *viridis* of Müller are the *Zoocarpes*, which we have seen after a certain period of liberty fix themselves by their divided extremities upon the remains of vegetables, or even upon the filaments of other *Tiresias*, and elongate themselves into a confervoid vegetable. This state of elongation has been well seen and figured by Le Clerc, in his excellent memoir on the *Proliferæ* of Vaucher, as well as by Dillwyn upon his *Conferva genuflexa*. It is surprising that these skilful naturalists had not detected the metamorphoses of the *Enchalis* into that which they call *Confervæ*."

Both Bory and M. Léon le Clerc are in error in supposing that they had witnessed the developement of the large oval or spherical bodies formed by the concentration of the endochrome of two cells: what the latter represents are undoubtedly the zoospores in different stages of growth.

has the greatest claim to be retained: a name, however, founded in error.

16. VESICULIFERA.

Char. Same as those of the family.

Derivation. From *Vesicula*, a vesicle, and *fero*, to bear.

1. Vesiculifera princeps *Hass.*

Char. Filaments *of the same diameter as those of V. capillaris.* Cells *about once and a half as long as broad.* Sporangia *circular, producing but a very slight inflation of the fructiferous cell.*

Isogonium capillare Kütz. Phyc. Gener. 255. *V. princeps* Hassall, in Annals, vol. x. p. 388.

Hab. Cheshunt: *A. H. H.*

This species I described in the Annals of Natural History, vol. x. p. 388., under the name of *V. princeps;* but not meeting with it a second time, and fearing that it was not really distinct, I referred it to *V. capillaris.* I am now, however, induced again to regard it as a distinct species, from the circumstance of its being described as such by Kützing under the name of *Isogonium capillare,* a subgeneric appellation, bestowed upon it on account of the sporangia not producing any considerable inflation of the fruit-bearing cells, — a circumstance which scarcely called for such a distinction. The figure given by Kützing accords closely with one made by myself of the species long ago, and which I regret I have not here introduced. The non or slight inflation of the cells will distinguish it from all other described species.

2. Vesiculifera capillaris *Hass.*

Plate L. Figs. 1, 2.

Char. Filaments *of considerable diameter.* Cells *varying in length from nearly twice to almost four times their diameter.* Sporangia *large, circular, contained in distinct inflations of the cells of an evidently ovate form.*

Vesiculifera capillaris Linnæus? Hassall, in Annals of Nat. Hist., vol. x. p. 389. *V. princeps* Hassall, in loc. cit. *Prolifera composita* Vaucher, Hist. des Conf., p. 133. pl. 14. fig. 5.

Hab. Ponds near Notting Hill; Cheshunt, and its vicinity: *A. H. H.*

Whether the *Vesiculifera*, which is here regarded as the *Conferva capillaris* of Linnæus, be that species or not, there can be no question but that it is the same plant as that considered as such by Agardh, as I have been able to ascertain by the examination of an authentic specimen of Agardh's *C. capillaris* var. *B. alternata*, contained in the Herbarium of Dr. Greville. None of those who have noticed this species were at all acquainted, however, with the true reproduction.

3. VESICULIFERA CONDENSATA *Hass.*

Char. Filaments *of more considerable diameter than those of V. capillaris.* Cells *not so long as broad.*

Vesiculifera condensata Hassall, in Annals of Nat. Hist., vol. x. p. 388.

Not having again met with this species since it was described in the Annals, and never having seen it in a state of reproduction, I am led to think that possibly it may be but a variety of *C. capillaris*; than which, however, the filaments are thicker, and the cells much shorter. It was found adherent to a wall reached by the tide in the Thames near Barnes.

4. VESICULIFERA CRASSA *Hass.*

Plate LI. Fig. 1.

Char. Filaments *fully equal in diameter to those of V. capillaris.* Cells *usually five times as long as broad.* Sporangia *oval, generally solitary, but sometimes binary, contained in cells of a slightly oval form, the length of which about twice exceeds the diameter.*

Vesiculifera crassa Hassall, in Annals of Nat. Hist., vol. x. p. 389.

Hab. In a pond at Wood Green, near Bury Green, vicinity of Cheshunt: *A. H. H.*

The only species near to which this approaches is *V. Landsboroughi;* than which the filaments are much thicker and the inflated cells shorter and less marked.

Having met with it now several times, I have not a doubt of its being distinct from *V. Landsboroughi.*

5. VESICULIFERA LANDSBOROUGHI *Hass.*

Plate LI. Fig. 2.

Char. Filaments *of considerable diameter, but scarcely so large as those of the preceding species.* Cells *at the period of fructification, about five or six times as long as broad.* Sporangia *oval, contained in inflated cells of an elongated but not regularly oval form, these occurring usually singly at intervals of three or four cells, but sometimes two are juxta-posed.*

Vesiculifera Landsboroughi Hassall, in Annals of Nat. Hist., vol. x. p. 389. *Prolifera rivularis* M. Léon le Clerc, Mém. du Mus. t. 25.

Hab. Vicinity of Cheshunt, very rare: *A. H. H.* In an old coal-pit near Stevenston, Ayrshire: *Rev. D. Landsborough.* Penzance: *Mr. Ralfs.*

I have much pleasure in dedicating this, one of the finest species of the genus, to the Rev. David Landsborough, by whom the merit of its discovery is shared equally with myself, as an expression of my warm admiration of the zeal displayed by that gentleman in the cause of natural science.

I have met with this species but sparingly myself, but have received excellent specimens of it in a state of reproduction from Mr. Landsborough, who aptly compares the form of the seed-bearing cells to that of the "soldering of lead pipes."

6. Vesiculifera Cuvieri *Hass.*

Char. Filaments *more slender than those of the preceding species.* Cells *usually seven times as long as broad.* Sporangia *oval, contained in inflated cells of an ovate form.*

Vesiculifera prolongata Hassall, in Annals of Nat. Hist., x. 390. *Prolifera Cuvieri* Le Clerc, Mém. du Mus.

Hab. Pond near Louton, Essex, and again near Enfield: *A. H. H.*

This species is known from *V. Landsboroughi* by its finer filaments, longer cells, and ovate form of the seed-bearing inflated cells.

"The inflations of *Prolifera rivularis* present an oval, whose great diameter is never double the small. In the *Prolifera Cuvieri* this enlargement is so much allongated that one might distinguish it almost as well by the intensity of its colour as by its size. In its state of greatest contraction its great diameter is triple or quadruple that of the small. The same proportion, but a little less marked, is observed between the grains of the two *Confervæ*."

7. Vesiculifera lacustris *Hass.*

Plate LII. Fig 1.

Char. Filaments *nearly equal in diameter to those of V. Cuvieri.* Cells *from three to five times as long as broad.* Sporangium *oval, sometimes almost quadrangular, solitary, occasioning no very considerable enlargement of the cell in which it lies; empty cell next the spore also inflated.*

Vesiculifera lacustris Hassall, in Annals of Nat. Hist., vol. x. p. 390.

Hab. In the New River reservoir, near Cheshunt, sparingly, and other places in the vicinity: *A. H. H.*

V. lacustris differs from *V. Borissii* principally in being altogether a more robust species, and in having shorter cells.

8. VESICULIFERA PALUDOSA *Hass.*

Plate LII. Fig. 3.

Char. Filaments *of less considerable diameter than those of V. lacustris.* Cells *usually three times as long as broad.* Sporangia *oval, contained in inflated cells of the same form.*

Vesiculifera paludina? Hassall, in Annals of Nat. Hist., vol. x. p. 390.

Hab. Cheshunt: *A. H. H.* Framfield Common: *Mr. Jenner.*

This species comes nearest to *V. ciliata;* but the inflated cells are of a different form. I know not whether this be the species, described by me in the "Annals" as *Vesiculifera paludina,* or whether that species be different from *V. capillaris,* not having had opportunities of making any comparative examination of them.

9. VESICULIFERA PULCHELLA *Hass.*

Plate L. Fig. 3.

Char. Filaments *of considerable diameter.* Cells *usually two and a half or three times as long as broad.* Sporangia *circular, contained in much inflated cells, which are at first oval, then circular, and lastly somewhat hexagonal.*

Hab. Cheshunt; Notting Hill: *A. H. H.*

This is a very fine species, seeking usually rather pure water; it is of an intense and beautiful green colour.

10. VESICULIFERA RALFSII *Hass.*

Plate L. Fig. 8.

Char. Filaments *usually rather smaller than those of V. pulchella.* Cells *varying in length from twice to four times their diameter.* Sporangia *circular, lodged in cells of an hexagonal form.*

Vesiculifera pulchella var. Hassall, in Annals of Nat. Hist., vol. x. p. 390.

Hab. Cheshunt and its vicinity, especially Cheshunt Common: *A. H. H.* Penzance: *Mr. Ralfs.*

Subsequent examination has confirmed the suspicion originally entertained that this species, which was first sent me by Mr. Ralfs, was distinct from *V. pulchella:* the inflated cells are smaller and more hexagonal than they are in that species.

11. Vesiculifera Vaucherii *Hass.*

Plate L. Fig. 4.

Char. Filaments *about equal to those of V. pulchella.* Cells *usually two and a half or three times as long as broad.* Sporangia *circular, lodged in cells which are very considerably inflated and of an ovate form.*

V. ventricosum Hassall MSS. *Prolifera Vaucherii?* M. Léon le Clerc, loc. cit.

Hab. Cheshunt: *A. H. H.*

This is a very distinct species, differing from *V. virescens* in its circular sporangia, and highly inflated cells, and from *V. pulchella* in the ovate form of the inflations, which in the latter species are slightly hexagonal.

12. Vesiculifera virescens *Hass.*

Plate L. Fig. 5.

Char. Filaments *equalling in diameter those of V. pulchella.* Cells *once and a half or twice as long as broad, fasciated.* Sporangia *ovate, contained in cells of the same form.*

Vesiculifera virescens Hassall, in Annals of Nat. Hist., vol. x. p. 391.

Hab. Notting Hill, near London: *A. H. H.*

This species comes very near to the following, of which possibly it may be but a variety.

13. VESICULIFERA OVATA *Hass.*

Plate L. Fig. 6.

Char. Filaments *about equal to those of V. virescens.* Cells *three or four times as long as broad.* Sporangia *ovate, occasionally circular, contained in inflated cells of an ovate form.*

Vesiculifera ovata Hassall, in Annals of Nat. Hist., vol. x. p. 392.

Hab. Cheshunt: *A. H. H.* Turner's Hill and Heathfield: *Mr. Jenner.*

This at all events is a very distinct species, if the preceding one be not equally so.

14. VESICULIFERA CONCATENATA *Hass.*

Plate LI. Fig. 3.

Char. Filaments *thicker than those of V. ovata.* Cells *six times as long as broad.* Sporangium *ovate; cell next the sporangium inflated.*

Vesiculifera concatenata? Hassall, in Annals of Nat. Hist., vol. x. p. 392.

Hab. Cheshunt Common and pond near Highgate: *A. H. H.* In a pool between Hook Green and Lamberhurst, and at Peasmarsh and Henfield: *Mr. Jenner.*

Sometimes two or three sporangia occur contiguously to each other. I am not quite sure that this is the species described in the Annals by me as *Vesiculifera concatenata,* but believe it to be so. There is not a more distinct species in the genus.

15. VESICULIFERA BORISSII *Hass.*

Plate LII. Fig. 7.

Char. Filaments *of nearly the same diameter as those of*

V. ovata. Cells *from four to seven times as long as broad.* Sporangia *oval, frequently of a golden colour, usually solitary, but sometimes binary; cells next the sporangia inflated.*

Prolifera Borissii M. Léon le Clerc, Mém. du Muséum, pl. 25. fig. 6. *Vesiculifera aurea* Hassall, in Annals of Nat. Hist., vol. x. p. 392.

Hab. Wood Green, near Bury Green, vicinity of Cheshunt: *A. H. H.*

This is a very distinct species, as also a very beautiful object under the microscope. There can be no doubt about the synonyme of M. Léon le Clerc.

16. VESICULIFERA CILIATA *Hass.*

Plate LII. Fig. 2.

Char. Filaments *smaller than those of V. pulchella, terminated by long colourless cilia.* Cells *about three times as long as broad.* Sporangia *oval, lodged in cells of the same form.*

Hab. Cheshunt: *A. H. H.*

The presence of cilia on the extremities of the filaments renders this a very remarkable species, and one by which it may be readily recognized. There is an evident analogy between the genera *Vesiculifera* and *Bulbochæte*, and through *V. ciliata* there would appear to be an easy transition from the one to the other.

17. VESICULIFERA DISSILIENS *Hass.*

Plate L. Fig. 7.

Char. Filaments *of considerable diameter.* Cells *scarcely so long as broad.* Sporangia *circular, contained in inflated cells of the same form, and which are usually solitary.*

Vesiculifera dissiliens Lyngb. et Ag.

Hab. Cheshunt: *A. H. H.* Turf Dyke, near Ardrossan, Ayrshire: *Major Martin.*

The above is a very beautiful species under the microscope: it is to be distinguished from all others by the shortness of its cells. In the Herbarium of Dr. Greville I find a specimen of this species, not indeed in a state of reproduction, put up by M. Chauvin, and marked with doubt as *Conferva dissiliens* Lyngb. It is certainly not the *Conferva dissiliens*, either of Dillwyn's work, or of "English Botany," that of the latter work being probably identical with *Desmidium mucosum.*

18. VESICULIFERA CARDIACA *Hass.*

Plate LI. Fig. 4.

Char. Filaments *of much less diameter than those of V. pulchella.* Cells *five or six times as long as broad.* Sporangia *circular, placed in much inflated cells, which may be compared to a heart in form.*

Vesiculifera cardiaca Hassall, in Annals of Nat. Hist., vol. x. p. 391.

Hab. Pond near Notting Hill: *A. H. H.* In a pool between Hook Green and Lamberhurst: *Mr. Jenner.*

This species would appear to be an uncommon one, for I have only twice met with it.

19. VESICULIFERA CRISPA *Hass.*

Plate LII. Fig. 8.

Char. Filaments *much more slender than those of V. ventricosum.* Cells *usually three times as long as broad.* Sporangia *circular, lodged in cells of an ovate form.*

Vesiculifera crispa Hassall, MSS.

Hab. Cheshunt and vicinity: *A. H. H.* Between Wadhurst and Ticehurst, and between Ramslye Rocks and Broadwater Forest: *Mr. Jenner.* Cannon Hill Quarry, near Ardrossan, Ayrshire: *Major Martin.*

This is certainly a very distinct species, and one moreover by on means uncommon.

20. VESICULIFERA FASCIATA *Hass.*

Plate LIII. Fig. 6.

Char. Filaments *of diameter about equal to that of V. crispa.* Cells *usually three times as long as broad.* Sporangia *circular, contained in cells of the same form.*

Vesiculifera fasciata Hassall, in Annals of Nat. Hist., vol. x. p. 392.

Hab. In a pond on Nazing Common, Essex: *A. H. H.*

This species differs from the preceding only in the shape of the seed-bearing cells, which in *V. crispa* are somewhat ovate, while in *V. fasciata* they are quite circular. It is possible therefore that it is but a variety of *V. crispa.*

21. VESICULIFERA SPHÆRICA *Hass.*

Plate LIII. Fig. 5.

Char. Filaments *about equal to those of V. fasciata.* Cells *usually once and a half or twice as long as broad.* Sporangia *spherical, contained in enlarged cells of the same form.*

Vesiculifera sphærica Hassall, in Annals of Nat. Hist., vol. x. p. 392.

Hab. Vicinity of Cheshunt: *A. H. H.*

This species differs only from the preceding in having much shorter cells. I believe it to be distinct, however.

22. VESICULIFERA COMPRESSA *Hass.*

Plate LIII. Fig. 4.

Char. Filaments *about equal to those of V. fasciata.* Cells *twice or thrice as long as broad.* Sporangia *contained in cells of a compressed ellipsoidal form.*

Vesiculifera compressa Hassall, in Annals of Nat. Hist., vol. x. p. 393.

Hab. In a pond in Yorke's Brickfield, near Cheshunt: *A. H. H.*

The inflations in this species resemble in form the knobs of dumb-bells.

23. VESICULIFERA INÆQUALIS.

Plate LIII. Fig. 2.

Char. Filaments *in a state of reproduction of very unequal diameter.* Cells *varying in length, being sometimes four or five times as long as broad, at others only three times; these variations occurring usually on different parts of the same filament.* Sporangia *circular, lodged in cells which present an hexagonal appearance, empty cell next the spore larger than the rest.*

Hab. Cheshunt: *A. H. H.* Rusthall Common and Burwash: *Mr. Jenner.*

This appears to me to be a very distinct species; it is subject, however, to considerable variation. It, as well as the following, is very common, and both were procured by Mr. Jenner, Mr. Ralfs and myself within a very short time of each other.

24. VESICULIFERA ÆQUALIS *Hass.*

Plate LIII. Fig. 3.

Char. Filaments *of smaller calibre than those of the preceding species, of equal diameter.* Cells *about six times as long as broad.* Sporangia *circular, lodged in cells which are broader than long.*

Hab. Cheshunt: *A. H. H.* Rusthall Common and Delmonden; Hawkhurst: *Mr. Jenner.*

This as well as the preceding species is found in boggy pools which retain the water for a long time.

25. Vesiculifera flavescens *Hass.*

Plate LIII. Fig. 9.

Char. Filaments *about equal in size to those of V. crispa.* Cells *four or five times as long as broad.* Sporangia *circular, lodged in cells of the same form.*

Hab. Penzance: *Mr. Ralfs.*

This species I have only received from Mr. Ralfs and Mr. Jenner.

26. Vesiculifera affinis *Hass.*

Plate LIII. Fig. 1.

Char. Filaments *about equal in size to those of V. vernalis.* Cells *five or six times as long as broad.* Sporangia *circular, lodged in cells which are slightly ovate and protuberant at the sides.*

Hab. Cheshunt: *A. H. H.*

Not an uncommon species, perhaps, but a variety of *V. vernalis.*

27. Vesiculifera hexagona *Hass.*

Plate LIII. Figs. 11, 12.

Char. Filaments *somewhat stouter than those of V. æqualis.* Cells *three or four times as long as broad.* Sporangia *circular, contained in inflated cells of an hexagonal form.*

Hab. Cheshunt: *A. H. H.*

This is a very distinct little species, and not uncommon: a variety occurs with filaments considerably finer. This may also be distinct.

28. Vesiculifera dubia *Hass.*

Plate LIII. Fig. 14.

Char. Filaments *of the same size as those of V. hexagona,*

uninflated. Cells *usually five times as long as broad.* Sporangia *circular, lodged in inflated cells of a somewhat hexagonal form, but much larger than those of V. hexagona.*

Hab. Penzance: *Mr. Ralfs.*

This species approaches rather closely to *V. hexagona,* from which, however, I think that it is distinct.

29. Vesiculifera Müllerı *Hass.*

Plate LIII. Fig. 10.

Char. Filaments *more slender than those of V. fasciata.* Cells *fully four times as long as broad.* Sporangia *spherical, contained in inflated cells of a regularly globular form.*

Vesiculifera Müllerı Hassall, in Annals and Mag. of Nat. Hist., vol. x. p. 393.

Hab. Cheshunt: *A. H. H.* Rusthall Common and Hawkhurst: *Mr. Jenner.*

This species is by no means common; I have never met with it but once.

30. Vesiculifera Boscii *Hass.*

Plate LII. Figs. 3, 4, 5.

Char. Filaments *slender.* Cells *about six times as long as broad.* Sporangia *oval, contained in greatly enlarged cells of the same form.*

Prolifera Boscii M. Léon le Clerc, loc. cit. t. 25. f. 5. *V. elegans* Hass., Annals, vol. x. *Conf. tumidula,* Eng. Bot. 1670.

Hab. Henfield: *Mr. Borrer.* Rusthall Common: *Mr. Jenner.*

There is not a more distinct or prettier species than this in the genus.

I do not know whether figs. 4, 5. pl. 52. are to be regarded as varieties of this or distinct species.

31. Vesiculifera alata *Hass.*

Plate LIII. Fig. 8.

Char. Filaments *scarcely exceeding those of V. Rothii in size. Uninflated* cells *about six times as long as broad.* Sporangia *oval, having their long diameter placed in the axis of the diameter of the inflated cells, such bearing cells very protuberant laterally.*

Hab. Penzance: *Mr. Ralfs.*

This is one of the most remarkable species of the genus, and the only specimens which I have seen of it are those transmitted to me by Mr. Ralfs.

32. Vesiculifera Rothii *Hass.*

Plate LIII. Fig. 7.

Char. Filaments *rather more slender than those of the preceding species.* Cells *fully four times as long as broad.* Sporangia *rather broader than long, contained in inflated cells of the same form.*

V. bombycina Hassall, in Annals of Nat. Hist., vol. x. p. 394. *Conf. bombycina* Ag. Harv. Manual, p. 126. *Prolifera Rothii* M. Léon le Clerc, Mém. du Mus.

Hab. Everywhere common.

Three or four cells sometimes occur in juxtaposition.

33. Vesiculifera Candollii *Hass.*

Plate LII. Fig 9.

Char. Filaments *of about the same diameter as those of V. crispa.* Cells *usually six times as long as broad.* Sporangia *circular, contained in inflated cells which are somewhat narrower at one extremity than the other.*

V. vernalis Hassall, in Annals of Nat. Hist., vol. xi. p. 434. *Prolifera Candolli* M. Léon le Clerc, Mém. du Muséum, t. 25. fig. 7.

Hab. Waltham Abbey and High Beech, Epping: *A. H. H.* Rusthall Common: *Mr. Jenner.*

This is a distinct as well as common species. I have but little doubt of the correctness of the synonym.

17. BULBOCHÆTE *Ag.*

Char. Filaments *attached, of equal diameter, branched.* Cells *truncate, setigerous, the setæ being rigid, elongated, and bulbous at their bases.* Reproductive bodies *situated either in inflated cells, when they are formed by the union of the contents of two contiguous cells, or in the bulbous portions of the setæ, which become much enlarged for their accommodation.*

Derivation. From βολβος, *a bulb,* and χαιτη, *a bristle.*

The reproduction of this remarkable genus has, until very recently, been wholly unknown. M. Decaisne, in his Memoir on the Classification of the Algæ, contained in the numbers of the "Ann. des Sciences Nat." for May and June 1842, alludes to the mode of formation of the reproductive bodies by the union of the matter of two cells in the same filament, but does not appear to have noticed the second way in which they are formed, viz. within the bulbous portion of the seta. The observations of M. Decaisne and my own remarks appear to have been made nearly at the same period.

"In the above account of the reproduction of the genus *Bulbochæte* I have avoided using the term spore to designate the condensed endochrome in the inflated cells, which presents so much the appearance of a true spore; for I conceive that it is most probable that this separates, as in the other branched species of *Confervæ,* into numerous small reproductive granules.

"The genus *Bulbochæte* may be regarded as forming the connecting link between the simple and branched freshwater *Confervæ;* it agreeing with the *Conjugatæ* in the equality of its filaments, with the *Cystospermeæ* in the union of the contents of two distinct cells, and probably with the branched

species in the separation of the condensed endochrome in the inflated cells into numerous reproductive vesicles."*

1. Bulbochæte setigera *Ag.*

Plate LIV. Figs. 1, 2, 3, 4.

Char. Filaments *dichotomously branched, tufted.* Cells *usually five times as long as broad.*

B. setigera Harvey, in Hooker's Brit. Flor. ii. p. 350.; also in Manual, p. 121. *Conf. vivipara* Dillw. t. 59.; Hassall, in Annals, xi. p. 362.

Hab. Common in boggy pools.

Bulbochæte setigera has by most systematists been placed in the same family of *Algæ* with *Chætophora* and *Draparnaldia*, the presence of cilia on the filaments having been the chief inducement so to do. It is certainly to be regarded as the connecting link between the branched and simple freshwater *Algæ;* but it exhibits a closer relation to *Vesiculifera* than to any genus of branched *Conferva*, it agreeing with it in the mode of formation of the spores, and in its rigid habit. The next genus to which it appears closely allied is *Cladophora*, of which *Conf. glomerata, C. fracta*, &c. are examples. This genus has the same rigid character, though in a less degree, as *Bulbochæte* and *Vesiculifera*. In a natural arrangement, these genera should follow each other somewhat in the following order:—*Vesiculifera, Bulbochæte, Cladophora*, and then *Coleochæte, Chætophora, Draparnaldia, Sphæroplea*, &c.

"On freshwater plants, &c., in lakes and ponds. Tufts a quarter to half an inch high, forming dense villous tufts. Filaments irregularly and slightly branched; the branches subalternate or dichotomous, either erect or recurved, jointed. Joints three or four times as long as broad; swollen upwards, from their upper part bearing a long inarticulate deciduous bristle, whose base is expanded, and half clasping the

* Hassall, in Annals of Nat. Hist. vol. xi.

joints; substance subgelatinous; when recent, somewhat horny; when dry, colour dull greenish brown, fading to grey in the herbarium. A curious plant of doubtful affinity; under the microscope, resembling a *Sertularia* set with herring bones." — *Harv.*

This species is either very variable, or else several species have been confounded together. I have noticed three varieties or conditions: —

Var. 1. with cells three times as long as broad.

Var. 2. with cells once or once and a half as long broad.

Var. 3. filaments very small, cells five times as long as broad.

" Mais la sexième famille me paraît bien plus obscure, et je ne l'offre aux naturalistes qu'avec répugnance. Cette reproduction par bourrelets, toute conforme qu'elle paraît aux loix de la nature, me cause toujours quelque peine quand je l'annonce. Elle me semble plutôt devoir être considerée comme un moyen surabondant, que comme une forme particulière, qui distingue certaines espèces. Et en effet en trouve peu de plantes qui ne se multiplient de cette manière, en même temps qu'elles se propagent par leur graines. Cependant jusqu'à présent, je n'ai jamais vu les Conferves de cette famille s'accroître autrement, et d'autre part je n'ai jamais vu les Conferves des autres familles se multiplier de cette manière, j'en excepte cependant la *Conferva glomerata* Linnæi, sur les débris de laquelle j'ai quelquefois rencontre des brins verts, qui étoient de nouveaux développements. Je recommande donc les prolifères en particulier aux observations des botanistes, pour qu'ils y cherchent des organes sexuels, et qu'ils tâchent de reconnoître si, indépendamment des bourrelets, elles renferment des graines. La *Conferve rivularis* est très commune et très facile à observer; les graines brillans dont elle se pourvue doivent donner quelque soupçon, et faire conjecturer que son organisation est plus composée que je ne l'ai dit. De mon côté, autant que j'aurai du loisir et de la santé, je ne regarderai pas mon tâche comme achevée; j'observerai cette famille plus attentivement que je n'ai fait jusqu'à présent. J'en isolerai quelques individus, et j'espère qu'aidé des lumières que me fournira sans doute la publication de cet ouvrage, je decouvrirai enfin la reproduction de cette famille, si du moins elle en a une qui lui soit propre, indépendamment de ses bourrelets." — *Vaucher.*

Fam. X. MONOCYSTEÆ.

The reproduction of this family agrees precisely with that of *Chætophora* and *Draparnaldia*, and perhaps *Batrachospermum*, which genera it would perhaps have been more natural that it should have been made to follow.

It consists of three genera of freshwater *Algæ*, *Cladophora* Kützing (a genus synonymous with my genus *Microspora*), *Coleochæte*, and *Lyngbya*.

In the species of this family we have no union and intermingling of the contents of two cells, but *each cell* contains all the requisites for the perpetuation of the species, viz. zoospores and the fertilizing vesicles.

When the zoospores have been fertilized, the cells swell up, the increase in the size of the cells being determined by the developement of the zoospores, and which developement proceeds to such an extent as to occasion the rupture of the membranes of the cells, the zoospores escaping through the apertures thus formed.

This inflation of the reproductive cells of the branched *Confervæ* and of the *Lyngbyæ* does not appear to have been noticed by any other observer save Vaucher, and by him only in the *Batrachosperms;* and yet it is of frequent occurrence, and affords a character whereby species may be often distinguished from each other, although at the same time it changes the ordinary appearance of the species so much as to lead sometimes to the description of specimens so altered as distinct species; and this has doubtless been the case with *Conferva fracta* of the "Flora Danica," which is *C. crispata* in a state of reproduction.

The species of this family are for the most part attached, and present the double mode of growth described in the Introduction, viz. that of longitudinal and lateral developement of the cells.

Sub-fam. i. *Cladophoreæ.*

18. CLADOPHORA *Kütz.*

Char. Filaments *attached, much branched, not setigerous, and not invested with secondary cells.*

Derivation. From *κλαδος, a branch,* and *φορεω, to bear.*

This important genus I established in the "Annals of Nat. Hist." vol. xi. p. 363., under the name of *Microspora.* Subsequently finding the same genus to have been characterised by Kützing in his "Phycologia Generalis," I have been induced to adopt his generic name, it appearing to be the more appropriate.

The genus should contain amongst the freshwater *Confervæ* *C. glomerata* and *C. crispata,* and the majority of the marine branched *Confervæ.* *Conf. ærea* and its numerous allies should form another genus, agreeing in its reproduction closely with *Cladophora,* but differing from that genus in the simplicity of its filaments: this genus might be denominated *Aplonema.** The filaments when dry are destitute of gloss, like those of the *Cystospermeæ,* and do not adhere well to paper.

1. Cladophora glomerata.

Plates LVI, LVII. Figs. 1, 2.

Char. Filaments *tufted, bushy; somewhat rigid, bright green, shining.* Branches *crowded, irregular, erect; the ultimate ramuli secund, subfasciculate.* Articulations *four to eight times longer than broad.*

C. glomerata Dillw. Conf. t. 13.; Eng. Bot. t. 2192.; Manual, p. 134. *Microspora glomerata* Hassall, in Annals, vol. xi. *C. Brownii* Harv. l. c. p. 356.; also in Manual, p. 134.; Dillw. Suppl. t. D. *C. pulvinata* Brown, MS.; Wyatt, Alg. Dan. No. 225. *C. agagro-*

* From *ἁπλοῦς, simple,* and *νημα, a thread*

pila, E. Bot. t. 1377.; Dillw. Conf. t. 87.; Harv. l. c. p. 357.; also in Manual, p. 134.

Hab. *C. glomerata*, common in streams and wells.— *C. ægagropila*, in lakes, rare. North Wales: *Rev. M. Davies.* North of Scotland: *Mr. Brodie.* Prestwick Car: *Mr. Winch.* Culmere Pool and Whitemore, Shropshire: *Rev. E. Williams.* Cunnemara: *Mr. Mackay.*—*C. Brownii.* On wet rocks, in a cave near Dunree, North of Ireland: *R. Brown, Esq.* On shady rocks at the entrance of a small cave beyond Black Castle, Wicklow, where it is exposed to the dripping of fresh water, and occasional overflow of the sea: *W. H. Harvey.* Cornwall coast, near the Land's End: *Mr. Ralfs.*

This beautiful and abundant *Conferva* delights in pure and running waters, attaching itself to stones, walls, and piles in streams, rivers, and cascades, it being drawn out by the current often to more than two feet in length. In the mass, it is of a deep and refreshing green colour, which is occasioned by the purity of the water in which it lives. Examined separately, the filaments present a peculiar glistening appearance, rare amongst freshwater *Algæ*, though common to many marine species. Not infrequently, the branches are beset with tufts of ramuli, which, when the plant is floated out in water, give it somewhat the appearance of a *Sertularia*, and increase greatly its beauty. It is in this species that I have seen the apertures situated on one side of the distal extremity of the cells designed for the escape of the zoospores. Notwithstanding that its usual resort is the stream and the waterfall, it will flourish and increase in size amazingly for weeks and months in a vessel, the water of which is occasionally renewed. I have thus kept it for many weeks, removing, when by its growth it had filled the vessel, all but a small portion of it; this, however, speedily increased, and again filled its dwelling-place. The tearing away of portions of the plant in no way impaired the vitality of the remainder, as from its aggregation of minute cells, each the analogue of the other, might *a priori* have been conjectured.

After the species has been thus confined for some time, if it be examined with a glass, very many of the filaments will be found to be invested with numerous smaller filaments. These are the young of the plant derived from the growth of the zoospores, which have attached themselves to the parent filaments. It was the occurrence of a specimen thus infected that induced Vaucher to place this species in his genus *Prolifera*.

This species is the favourite resort of *Diatoma vulgare*, which attaches itself to it by means of a distinct root-like organ. The *Diatoma* frequently developes itself over the filaments to such an extent as totally to obscure their rich green colour. A brown no less rich is imparted to it by the parasite.

The two following plants, old and established as the one of them at least would appear to be, I regard as conditions of *Cladophora glomerata* — viz. *C. ægagropila* and *C. Brownii*. The microscope does not present any essential difference in the structure of these supposed, though I believe erroneous, species. The state of *Cladophora glomerata* (which has received a distinct name even at the hands of the great Swede himself) (*C. ægagropila* Linn.), I believe to be formed as follows: — a specimen by the force of some mountain stream swollen by recent rains becomes forced from its attachment; as it is carried along by the current, it is made to revolve repeatedly upon itself, until at last a compact ball is formed of it, which finally becomes deposited in some basin or reservoir in which the stream loses itself, and in which these balls are usually found.

The size of these balls varies from two to four inches; they are dense, firm, and spongy. Kützing has carried his idea of this species to such an extent as to constitute for its reception a new genus, taking for the generic name the old specific appellation of *ægagropila*, and bestowing upon it the specific name of its renowned discoverer Linnæus — *Ægagropila Linnæi*. The term *ægagropila* is derived from its resemblance to the balls that are found in the stomachs of goats. The peculiarities of the second condition of *C. glo-*

merata (*C. Brownii*) arise from the sub-immersed habitat in which it grows. Mr. Harvey thus describes *C. Brownii*: — "This forms exceedingly dense, very rigid tufts, of a black green colour when growing, but on having the water expressed, and being held to the light, exhibits a beautiful yellow-green tint. Filaments so matted together, that it is difficult to separate a single thread. They appear to originate in a mass of creeping, branched, densely matted fibres, which form the base of the tufts. They are erect, from half-an inch to an inch high, flexuous, very rigid and elastic; the branches few and nearly simple, almost always secund, very erect. A very curious and distinct plant, having, to the naked eye, a good deal the appearance of *Vaucheria terrestris*, but totally different in structure. It is perhaps allied to *C. ægagropila*. I have examined a specimen from Mr. Brown in the late Mr. Templeton's herbarium, and find it to agree in every respect with my Wicklow plant."

2. CLADOPHORA CRISPATA.

Plate LV. Figs. 1, 2.

Char. Filaments *very tenacious and of variable diameter, crisped, and entangled.*

C. nigricans Dillw. Conf. Syn. l. c.; Harv. l. c. p. 356. *C. crispata* Sm. E. Bot. t. 2350.; Harv. l. c. p. 356. *C. flavescens* Harv. l. c. p. 356.; E. Bot. t. 2088.; Wyatt, Alg. Darm. No. 224. *C. fracta* Dillw. Conf. t. 14.; E. Bot. t. 2338.; Harv. l. c. p. 356. *Microspora* Hass. in Annals, vol. xi.

Hab. Everywhere common. Var. *nigricans* in a pond at Wimbledon, Surrey: *Mr. Dickson.*

Three British species of *Confervæ* appear all referrible to this one: these are *C. nigricans*, *C. fracta*, and *C. flavescens*. *C. flavescens* I take to be the young state of *C. crispata*, while *C. fracta* is assuredly the mature or perfect condition of the plant: it is also equally certain that the *C. nigricans* of Dickson is merely a discoloured state of *C. crispata*.

The suspicion also may, I think, be entertained, that *C. crispata* itself is but a condition of *C. glomerata,* changed by the difference of its place of growth — it growing for the most part in still water, in deep ponds, and lakes. I have often seen specimens, which it would be impossible to refer with certainty to either species. A specimen of *C. capillaris* in the Linnæan Herbarium, was referrible to this species, or condition of one.

19. COLEOCHÆTE *Brèb.*

Char. " Frond *disciform, appressed, parasitic, formed of filaments radiating from a centre, generally conjoined.* Filaments *articulated, dichotomously branched, sending forth in all directions from the upper surface of the cells cylindrical, truncated, lengthened, setigerous sheaths.* Endochrome *green.*" — Brèb.

Derivation. From κολεος, *vagina,* and χαιτη, *seta.*

1. COLEOCHÆTE SCUTATA *Brèb.*

Plate LXXVII. Fig. 6.

Char. Filaments *appressed, conjoined, radiating, so as to describe a disciform frond.*

β *soluta.* — Filaments *radiating, prostrate, free.*

Coleochæte scutata Brèb. Description de deux nouveaux Genres d'Algues flûviatiles, Ann. des Scien. Nat., Janvier, 1844, p. 25. pl. 2.

Hab. In stagnant waters and ditches, growing on submersed leaves and stems of aquatic plants. Autumn — spring. Near Manchester: *Mr. Sidebotham.* Aberdeen: *Dr. Dickie.* Near Clonmel: *Prof. G. J. Allman.*

" I have found this remarkable *Alga* in many places in the environs of the town of Falaise. It grows closely applied upon the leaves and stems of inundated and in part decomposed plants. I have gathered it principally upon *Sparganium natans,* and upon the *Potamogeton natans.* Its lenticular

fronds may be easily distinguished with the naked eye in spite of their smallness, their green colour trenching upon the discoloured parts of the plants upon which they are fixed. At first sight one might be induced to believe that they are but parts of those plants whose chromule has not been disorganised by the immersion which has discoloured their other parts. These rosettes follow the forms of their supports. I have seen them upon *Conferva fracta;* they then embrace the filaments in such a manner as to surround them with a sort of ferrule or annular hood. A slight magnifying power of the microscope is sufficient to show the elegant disposition of radiating filaments which, by their approximation and lateral union, resemble an areolated disc, which recalls to mind certain *Pediastra* belonging to the *Desmideæ.*

"The fronds are roundish, from one to two, rarely three millemetres in diameter; they are formed of filaments closely applied to the plant on which they grow, dichotomously branched; branches approximate, and as though soldered the one to the other. The articulations or cells three or four times as long as broad, often unequal, are furnished interiorly with a green granular endochrome. On a great number of these articulations is remarked a tubercular rounded projection or protuberance, from which arises a tubular filament, truncated a little, dilated at the summit, from the interior of which issues a long and very delicate thread. This part of the organization of this *Alga* shows clearly that it ought to be placed in the *Chætophoroideæ,* and near to *Bulbochæte.* This setiferous sheath is very caducous and difficult to perceive.

" At a certain period of the existence of *Coleochæte scutata* its disc is covered here and there with tuberculated masses of endochrome, which one might regard as the formation of spores, at a later period indeed, these little masses are converted into groups of globules charged with the tube or setiferous sheath which characterizes this *Alga.* In the first period of its developement, the tubes terminate in a point, from whence issues a long setaceous filament of great tenuity; at a later period, the summit of this sheath is open, and appears then truncated and slightly dilated.

"About the globule which is at the base of this sheath, are developed, in the form of a rosette, the first articulations of the filaments, as is seen in *fig.* 7. They are cuneiform; some slightly bi-lobed, give origin to two cells, and so determine the dichotomy of the filaments.

"The variety, *β soluta,* which I have sometimes found amongst examples of the ordinary type, might be considered as another species on account of its filaments, which are not depressed, and are free in their whole length, but certain fronds of the ordinary type may be regarded as connecting the two forms; I therefore do not think that they can be separated. I have always observed that the filaments of the variety *β* do not preserve, in ramifying, a dichotomous disposition so exact as in *Coleochæte scutata,* &c."

In all those specimens of this most interesting production which I have examined, the sheaths and cilia have been altogether wanting. In some cases, however, the point of attachment of the sheaths to the cells could be perceived. The natural position of the genus is certainly near to *Bulbochæte.*

Sub-fam. ii. *Ulothriceæ.*

20. LYNGBYA *Ag.*

Char. Filaments *simple, subulate; and shining.* Zoospores *several in each cell, escaping through rents in the walls of the cells.*

Sphæroplea Berk. *Ulothrix* Kützing, Phyc. Gen. p. 251. *Sphæroplea* Kützing, l. c.

Name in honour of *M. Lyngbye,* author of an excellent work on the *Algæ* of Denmark.

The genera *Lyngbya* and *Sphæroplea* are undoubtedly identical, and one of the terms must of necessity be suppressed. *Bangia* also differs but slightly from the genus *Lyngbya,* and its abolition seems called for. Kützing has constituted a new genus for the reception of *Conf. zonata* (*Sphæroplea crispa* Berk.), *Ulothrix,* preserving also the genus *Sphæroplea,* the type of which he makes *Conf. annularia* Roth.

I cannot discover the necessity for the genus *Ulothrix*. Kützing's definitions of the genera *Ulothrix* and *Sphæroplea* are as follow: —

ULOTHRIX — "Trichoma simplex, membranaceum, tenerrimum, flaccidum; cellulæ gelineæ, tenuissimæ, hyalinæ, achromaticæ, abbreviatæ: amylideæ delicatissimæ, virides, plerumque granuliferæ, primo extensæ, dein paulatim in fascias transversales contractæ, tandem in opseospermata quatuor vel plura hologonimica transeuntes."

SPHÆROPLEA. — "Trichoma parenchymaticum simplex, cellulæ tenuissimæ membranaceæ, substantia chlorogonomica demum in spermatia transeunte repletæ, spermatia primo viridia deinceps miniate fusco: epispermio duplici, exteriori filiformi, internum spiraliter investiente, cuncta in series longitudinaliter digesta."

The endochrome in all the species of this genus in the young condition is almost uniform; subsequently, however, it parcels itself into numerous zoospores in each cell. The same remark applies to all the *Algæ*, which are multiplied by means of zoospores.

The species described in this genus might with some propriety be divided into two subgenera, in the first of which should be placed *Lyngbya zonata*, *L. muralis*, *L. virescens*, *L. Thompsoni*, and *L. copulata*, in which the filaments are almost always attached, are of a delicate and fragile nature, of a deep green colour, and delight in pure water; while in the second, *Lyngbya floccosa*, *L. punctalis*, and *L. vermicularis*, should be ranged, these being distinguished by characters the very reverse of those just enumerated, they being rarely attached, tenacious, of a dull green colour, and inhabitants of impure waters. In this division *L. prolifica* should also find a place.

1. LYNGBYA ZONATA *Hass.*

Plate LIX. Figs. 4, 5, 6 and 1, 2, 3.

Char. Filaments *of considerable diameter.* Cells *usually rather longer than broad, but sometimes shorter.* Endochrome *at first quadrangular, not entirely filling the cavity*

of the cell, but leaving a pellucid margin all around, subsequently becoming globular and granular. Zoospores *six or eight in each cell.*

Conf. zonata Web et Morh. *Conf. lucens* Dillw. t. 47. *Conf. bicolor*, E. B. t. 2288. *Sphæroplea crispa* Berk. Glean. Algæ, t. 3. fig. 1.

This species delights in pure and running water, it growing luxuriantly in that of cascades and waterfalls. It is everywhere common throughout Great Britain. Considerable confusion seems to have prevailed relative to this plant, several observers having repeatedly described it under different names. I have no doubt whatever of the correctness of the synonymes quoted. The form of the cells in this species is somewhat peculiar. They are not exactly cylindrical, but taper gradually from each extremity towards the centre of the cell, the extremities, or angles of the cells appearing in consequence prominent.

Two varieties of it have presented themselves to me; the one at Snaresbrook, Essex, in great quantity; this agreeing with the species proper in all, save the length of the cells, which are generally two and a half or three times as long as broad; the other in a stream at Wood Green, near Cheshunt, in which the cells are cylindrical, completely filled with endochrome, and not one third so long as broad. This may be distinct.

2. Lyngbya muralis *Ag.*

Plate LIX. Fig. 7.

Char. Filaments *of less diameter than those of Lyngbya zonata, dark green, entangled.* Cells *very short, two or three times broader than long.*

Hab. On the ground in all damp situations early in the spring.

This is a very distinct species, rendered interesting from the peculiarity of its habitat. The diameter of the filaments

and length of the cells vary considerably, according to the age of the plant.

3. Lyngbya copulata *Hass.*

Plate LXXII. Fig. 14.

Char. Filaments *very flexible, of about the same diameter as those of L. muralis, adherent to each other for a considerable portion of their length.* Cells *short.*

L. muralis var. copulata Carm. MS.

Hab. Appin: *Captain Carmichael.*

This is a very curious production, exhibiting some relation in the adherence of the filaments the one to the other to *Calothrix mirabilis* — than which it is not less wonderful. It is very rare.

4. Lyngbya virescens *Hass.*

Plate LX. Fig. 3.

Char. Filaments *of about the same diameter as those of L. punctalis.* Cells *usually somewhat beaded, rather longer than broad.* Endochrome *not quite filling their cavities.*

Hab. On stones, in a pond, near Wanstead Flats, Essex: *A. H. H.* Penzance: *Mr. Ralfs.*

This species, except in the simplicity of its filaments, bears a very close resemblance to the *Draparnaldiæ.* Like the species of that genus, it is of a beautiful green colour, fragile, slippery to the touch, and delighting in pure and slowly running waters. The filaments are always attached, in which respect it agrees with *L. zonata.*

5. Lyngbya Thompsoni *Hass.*

Char. Filaments *attached, exceedingly slender.* Cells *once or twice as long as broad.*

Meloseira Thompsoni Harv. in Manual, p. 195.

Hab. Growing on stones in a mountain rivulet at Ballantrae, Ayrshire: *Mr. W. Thompson.*

This is clearly a *Lyngbya*, and the most minute species of the genus with which I am acquainted. It is described as forming "beautiful, glossy, dark green tufts."

6. Lyngbya floccosa *Hass.*

Plate LX. Figs. 1, 2.

Char. Filaments *of smaller diameter than those of L. muralis.* Cells *at first cylindrical, subsequently beaded, rather longer than broad.*

Conf. floccosæ Ag. *Conf. fugacissima* Dillw. Supp., t. B. *C. floccosa* Harv. Manual, p. 126.

This species is very distinct and abundant, being found in great quantities in almost all ponds, on heaths and bogs. The filaments are rarely attached, are highly mucous and tenacious. When kept in water it does not quickly pass to decay. Specimens are often met with, which when placed under the microscope appear quite colourless, the endochrome having escaped from the cells.

7. Lyngbya punctalis *Hass.*

Plate LX. Fig. 4.

Char. Filaments *of less diameter than those of Lyngbya floccosa, very mucous.* Cells *two or two and a half times as long as broad, slightly contracted.* Endochrome *at first quadrangular, not filling the entire cavity of the cell, arranged usually in two separate masses, but sometimes there is but one; subsequently the cells becoming inflated, the endochrome assumes a spherical form.*

Sphæroplea punctalis Berk. Glean. Alg. t. 3. fig. 2. *Conf. punctalis* Dillw. t. 51. *Sph. punctalis* Harv. in Manual, p. 144.

Hab. High Beech: *A. H. H.* Penzance: *Mr. Ralfs.* Bogs at Fisher's Castle: *Mr. Jenner.*

This very beautiful species is by no means common. It inhabits generally ponds on commons and other exposed situations.

8. LYNGBYA VERMICULARIS *Hass.*

Plate LX. Fig. 5.

Char. Filaments *very mucous, tenacious, and of a yellowish green colour, finer than those of the preceding species.* Cells *twice or thrice as long as broad.* Endochrome *rarely filling the cavity of the cell.*

Hab. High Beech: *A. H. H.* Penzance: *Mr. Ralfs.* Sussex: *Mr. Jenner.*

A common species in boggy pools.

9. LYNGBYA PROLIFICA *Grev.*

Plate VIII. Fig. 4.

Char. Filaments *exceedingly slender, entangled, purple, very broadly effused, floating.*

Grev. Crypt. Fl. t. 303.; Harv. l. c. p. 370.; also in Manual, p. 160.

Hab. In the loch of Haining, Selkirkshire, October to April: *Dr. Greville.*

"Plant extensively diffused, forming a floating stratum, of a rich purple colour. Filaments extremely slender, entangled, somewhat rigid, yet flexible, entirely destitute of attachment, and free from any mucous layer. Annuli from the minuteness of the filament almost inconspicuous."—*Grev.*

Note.—The following marine *Algæ* I regard as members of the genus *Cladophora*,—*C. pellucida*, *C. rectangularis*, *C. Hutchinsiæ*, *C. diffusa*, *C. nuda*, *C. rupestris*, *C. lætevirens*, *C. flexuosa*, *C. gracilis*, *C. refracta*, *C. albida*, *C. lanosa*, *C. uncialis*, *C. glaucescens*, *C. arcta*, *C. æruginosa*, and *C. riparia*; while in *Aplonema* I place the subjoined *Confervæ*,—*arenicola*, *sutoria*, *Linum*, *crassa*, *implexa*, *ulothrix*, *arenosa*, *melargonium*, *ærea*, *collabens*, *bangioïdes*, *Youngana*, and *clandestina*.

Fam. XI. HYDRODICTYONEÆ.

21. HYDRODICTYON *Roth.*

Char. Cells *arranged in the form of a pentagon, an aggregation of a number of these pentagonal meshes, going to form an entire plant.* Zoospores *numerous in each cell, and uniting together before the absorption of the parent cell membrane.*

Derivation. From *ὑδωρ, water,* and *δικτυον, a net.*

1. Hydrodictyon utriculatum *Roth.*

Plate LVIII.

Char. Same as those of the genus.

Harv. in Hook. Br. Fl. vol. ii. p. 359. *Conf. reticulata,* E. B. t. 1687.; Dillw. t. 97.; Vauch. Conf. d'Eau douce; Harv. Manual, p. 140.

Hab. In ditches and pools in the midland and southern counties of England. In a pond in the Botanic Garden at Cambridge, where it has existed for many years: *Rev. Prof. Henslow.* Not found in Scotland or Ireland hitherto.

Hydrodictyon utriculatum is one of the most remarkable of the freshwater *Algæ*. The credit of the discovery of the singular reproduction of this species is due entirely to Vaucher, whose account of it is so clear and well expressed that I cannot do better than translate his remarks:—Each of the fine filets (cells) which form the pentagon begins to swell a little, principally at the extremities, then it is separated from the others not by a rupture, properly so called, but by

issuing from the interior of the membrane in which it was contained, and which, without doubt, was open for the purpose of its escape *; and after this separation it floated on the water under the form of a cylindrical cell. Soon it flattened itself, and underwent an alteration, which I would compare to that which the beginning of fusion produces upon metals; then it increased gradually in every direction, and, the reticulations being cleared the one from the other, became itself a new network, which one might distinguish with the microscope. Soon the reticulations were to be seen with the unaided sight, and at last each cell (or division of the pentagon), was totally changed into a network entirely like to that of which it made part. All these transformations took place in the space of a few days, and at the end of two or three months the young reticulated productions had acquired the full dimensions of which they were capable. . . . . We have here then an example of reproduction more remarkable perhaps than those heretofore observed."

"In conclusion, there is but little room to doubt that if the sides of the reticulations of the network of the preceding year be the networks of this year, the sides of the reticulations of the present networks will also be the networks of the next year, that each cell or fibre of the reticulations is itself the network which shall develope itself on the second year, and that the fibrilla of the principal fibre will be the network which shall develope itself on the next year, and so on until it please the Author of Nature to put an end to this developement by destroying the species which presents it."

* Areschoug, who has published an excellent paper in Schlechtendal's "Linnæa," for 1842, on the mode of growth of *Hydrodictyon utriculatum*, states that he has never been able to detect in this plant the enclosing tube. Dr. Areschoug has made the interesting discovery of the exact mode of formation of the minute network, viz., by the union of the numerous *spores* while in the parent cell, previously to which they are observed to be in lively motion; the parent cell itself is absorbed, and thus the new plant is eliminated according to Areschoug.

Fam. XII. SCYTONEMEÆ.

Char. Algæ *for the most part branched, rigid, or flaccid.* Cells *globular or compressed.* Colour *either a dark olive or a vivid æruginous green.*

The *Algæ* described in this family form two very distinct sections; the first section embracing those species which are characterized for the most part by a rigid cartilaginous habit, globular cells, a black or olivaceous colour, being lustreless in drying, and the second division including species which are not of a rigid habit, but whose filaments are flaccid, cells usually cylindrical, and colour a vivid green. The species of this last section Kützing makes the type of his order *Paraspermeæ*, an order characterized by its lateral sporules, and including *Lyngbyaceæ* and *Calothriceæ*, families which follow in his arrangement the *Scytonemeæ*.

Section i. *Stigonemeæ.*

22. STIGONEMA *Ag.*

Char. Filaments *tufted, branched, of irregular diameter, cartilaginous.* Cells *moniliform, arranged in transverse lines.*

Derivation. From στιγων, *dotted*, and νημα, *a thread.*

There is scarcely any necessity for this genus: the species described in it would form a natural section of the genus *Hassallia.*

1. Stigonema atrovirens *Ag.*

Pl. LXVI. Fig. 1.

Char. Filaments *tufted, coarse.* Branches *slightly divided, subacute.* Rings *mostly formed of three cells.*

Conf. atrovirens Dillw. t. 25. *Lichen pubescens,* E. Bot. t. 2318.; Harv. in Hook. Br. Fl. ii. p. 363. *St. atrovirens* Harv. in Manual, p. 153.

Hab. On wet rocks forming the banks to the river Diloris, near Neath, Glamorganshire: *Mr. Dillwyn.* Mountainous district; 14 miles west of Aberdeen: *Dr. Dickie.* On wet rocks above the falls of Aberdylais, Swansea: *Gutch.*

This species forms rigid lustreless and very dark tufts; the filaments are divaricately branched, the branches narrower than the stem, and sometimes furnished with two or three secondary ramuli. The larger divisions are dark brown and opaque, the smaller vivid green, their terminations being marked with transverse lines, which indicate the divisions into cells. The dense cartilaginous sheath is most visible at the terminations of the branches.

2. Stigonema mamillosum *Ag.*

Plate LXVI. Figs. 2, 3.

Char. Branches *incrassated, spindle-shaped, the two inferior thirds densely mamillose on all sides.*

Bangia mamillosa Lyng. t. 25.; Harv. in Hook. Br. Fl. p. ii. p. 363. *Stig. mamillosum* Harv. in Manual, p. 153.

Hab. Rocky bottoms of subalpine rivulets, Appin: *Capt. Carmichael.* Eagle's nest, Killarney: *W. H. Harvey.* Mountainous district; 14 miles west of Aberdeen: *Dr. Dickie.*

This forms continuous tufts several inches in diameter, which are less rigid than in *S. atrovirens;* the branches are simple, their diameter being greatest in the middle, and beset on all sides, for the two lower threads with mamillæ of various sizes, and the cells of which are always cylindrical, and not moniliform. These mamillæ as well as the upper

third of the branches are frequently of a vivid green colour. It is just probable that this species is but a condition of the previous one, the differences observed being occasioned by its moister habitat.

3. STIGONEMA PANNIFORME *Harv.*

Plate LXVI. Figs. 4, 5.

Char. Filaments *dark brown, densely packed together, much branched.* Branches *long, flexuous, obtuse.* Cells *angular, in triple series.*

Scytonema panniforme Carm. MS.; Ag. Syst. p. 309? *Stigonema panniforme* Harv. in Manual, p. 154.

Hab. On rocks at the mouth of Spar Cave: *Capt. Carmichael.*

"Patches indeterminate, crust-like, velvety. Filaments so closely packed that only their tops are visible above the crust, very tough when dry, gelatinous when moist, cohering strongly together, much branched; branches long and flexuous, divaricating, cylindrical, quite obtuse, not tapered. Granules ternate, very obvious in all the main branches, less distinct towards the tips. This entirely agrees in external character and ramification with the *Scytonema panniforme* of Agardh, with an authentic specimen of which I have compared Carmichael's specimen. The only difference I can perceive lies in the generic character, and this I suspect depends on age, for I find the apices of the branches simply striated, like a *Calothrix* or *Scytonema*, and the smaller branches, for, at least, part of their length, have the semi-punctate appearance of *S. ocellatum*; and it is only in their larger and main branches that the punctated character is clearly visible."—*Harv.*

4. STIGONEMA INTERRUPTUM *Hass.*

Plate LXIX. Fig. 2.

Char. Filaments *thick, subulate, coriaceous, glaucous green,*

cohering in tooth-like fascicles. Cells *very short.* Striæ *strongly marked.*

Calothrix interrupta Carm. MS. *C. interrupta* Harv. in Hook. Brit. Fl. p. ii. p. 368.; Harv. in Manual, p. 158.

Hab. On mosses and lichens, Appin: *Capt. Carmichael.* Turk's Cascade, Killarney; and Tobermorey in the Isle of Mull: *W. H. Harvey.* Machynlleth, N. Wales: *Mr. Ralfs.* Aberdeen: *Dr. Dickie.*

"Filaments about a line in length, of a glaucous green colour, united into close erect tufts, spreading over the moss, thick, tapering, cohering at the base, and sometimes through their whole length. Internal mass here and there interrupted, leaving short pellucid spaces resembling articulations. Striæ close and conspicuous."— *Carm.* MS.

This species is certainly much more naturally placed in the genus *Stigonema* than in *Calothrix.* Owing to the compactness of the cells they do not exhibit the dotted or moniliform arrangement of the other species — a difference surely not generic. The colour is a light glaucous green.

5. Stigonema minutum *Hass.*

Plate LXVII. Figs. 3, 4.

Char. Filaments *minute, erect, rigid, flexuous, fastigiate.* Branches *short.* Cells *or rather sporules in the principal filaments numerous, in the branches in single series.*

Scytonema minutum Ag. *S. minutum* Harv. in Hook. Brit. Fl. p. 365.; Harv. in Manual, p. 155.

Hab. On rocks and crustaceous lichens; common in alpine districts, Appin: *Capt. Carmichael.* Caroigátaha near Caher, and at Killarney: *W. H. Harvey.*

"Plant either spreading in a black suborbicular crust or scattered in little tufts, filaments erect, minute, closely packed, olivaceous; branches irregular, obtuse, ascending."— *Harv.*

Not a very well marked species.

23. HASSALLIA *Berk.*

Char. "Branches *increasing by the elongation and division of a single cell.*" — Berk.

The above definition, like that of *Scytonema*, embraces only the essential character of the genus, to it, other well marked peculiarities may be added; such as the rigidity of the filaments, the branches usually solitary, and the beaded form of the cells. The genus therefore may otherwise be defined thus: —

Char. Filaments *somewhat rigid, of unequal diameter.* Branches *usually solitary, formed by the elongation and division of a single cell.* Cells *distinctly moniliform, usually in a single series.*

Kützing's genus *Sirosyphon* is thus specified: it includes but a single species, and cannot be said to fulfil the intention of the genus *Hassallia.*

"Trichomata parenchymatica ex cellulis gelineis in vagina lamellosa, apice clausa longitudinaliter striatis, apice in articulos epenchymaticos confluentes transeuntibus compositum. Spermatia insterstitialia. Rami basi geniculati."

The above characters seem to me to be only of specific and not generic importance.

The genus *Hassallia* was instituted by the Rev. Mr. Berkeley a considerable time ago: that gentleman, however, delayed publishing it, and conceived on the appearance of the "Phycologia Generalis" that it was frustrated by Kützing's genus *Sirosyphon*, which I cannot think that it is.

1. HASSALLIA OCELLATA *Hass.*

Plate LXVII. Figs. 2. 7. 6.

Char. Branches *solitary, divaricating, slightly contracted at the base.* Cells *beaded.*

Conf. ocellata Dillw. t. D. *Conf. ocellata* E. B. t. 2530.; Harvey, in Hook. Brit. Fl. p. 364. *Scytonema ocellatum* Harv. in Manual, p. 154.

Hab. Springs on the moors near Wolsingham, Durham: *Mr. Backhouse.* In a bog on Tower Hill Common, near Southampton: *J. Woods, Esq.* West Blanket Island, Kerry: *Mr. Andrews.* Aberdeen: *Dr. Dickie.*

"It is composed of dense tufted masses of a dull brown, except when held against the light, in which position they appear of a horny or dirty orange hue. They are of a rigid substance, and do not adhere to paper in drying. The copious branches are irregular, wavy or curved, the ultimate ones blunted, and many of them turned one way. The greatest peculiarity of this species is that a chain-like row of vesicles runs along the centre of the frond, each of which is marked with a central dot, probably consisting of a mass of seeds."—*E. B.*

2. HASSALLIA COMPACTA *Hass.*

Plate LXVIII. Fig. 3.

Char. "Filaments *decumbent, branched, densely interwoven into blackish tufts.* Branches *suberect, dichotomous, and fasciculate within, furnished with transverse rings.*"—Grev.

Scyt. compactum Harv., l. c. p. 364.; also in Manual, p. 154.

Hab. Moist rocks in the Pentland Hills: *Messrs. Arnott* and *Greville.*

This species, with a specimen of which I have been kindly favoured by Dr. Greville, does not differ very considerably from *H. ocellatum*, and chiefly in the closer arrangement of the sporidia. I am not certain that it is really distinct.

3. HASSALLIA TURFOSA *Hass.*

Char. Frond *coriaceous, sparingly branched.* Branches *suberect.* Cells *annuliform, rarely beaded.* Sheath *broad.*

Dematium turfaceum Pers. Myc. Eur. vol. i. p. 68.; Lk. Sp. Pl. i. 134.; E. B. 2826. fig. 1.

Hab. On heath, sphagnum, &c., on the Pentland Hills, found by *Dr. Greville.*

"Forming a short brownish shaggy stratum, overrunning the plants on which it grows. Threads suberect, giving out in a proliferous manner short, very obtuse, branches of a beautiful golden yellow brown. Two sometimes spring from the same point. The walls of the threads are very thick. Sporangia annuliform, green, composed of a compact grumous mass, or divided, especially in the older threads, into a single row of distinct oblong granules.

"This very beautiful Alga was communicated by Dr. Greville to Sir W. J. Hooker, in whose Herbarium it is marked by M. Klotzsch *Dematium turfaceum* Lk., which there is every reason to believe is correct. Link appears to have been acquainted with the plant merely from the short notice of it by Persoon in the 'Mycologia Europæa.' Fries tells us expressly, 'Syst. Myc.' vol. ii. p. 603. *ad not.*, that it is an *Alga.* It is indeed a true *Scytonema,* which bears much resemblance to *Petalonema alatum,* though it wants the characteristic feature of that very curious production. *Radulum aterrimum* of Fries, of which specimens are published in 'Sclerom ycetes Sueciæ', and to which Persoon's *var. cornutum* is referred, is altogether different, and truly a fungus." — *M. J. B.*

This beautiful species bears some resemblance to *H. ocellatum* and still more to *H. compactum;* the cells, however, are rarely beaded, as they invariably are in both those species. It is no doubt distinct from either, the branches are generally single.

4. Hassallia? byssoidea *Hass.*

Plate LXVII. Fig. 5.

Char. Filaments *minute, erect, simple, of equal diameter, fasciculate, obtuse, forming an unequal blackish crust.* Striæ *very close and evident.*

Scyt. byssoideum Berk., Glean. Alg. t. 19. f. 1.; Harv. Hook. Brit. Fl. p. ii. p. 366.; Harvey, in Manual.

Hab. On the trunk of a living elm at Oundle, Northamptonshire: *Rev. M. J. Berkeley.*

I doubt much whether this species be a true *Hassallia*. It is much more like an *Oscillatoria*, the filaments being simple, of equal diameter, regularly striated, and very brittle. The only character which seems to unite it with *Scytonema* is its erect habit. It might possibly be better placed in Kützing's genus *Symphosyphon:* if not, it should perhaps form the type of a new genus. The genus *Symphosyphon* is thus characterized.

"Trichomata erecta vel adscendentia, vagina cartilaginea multistriata (lamellosa) sæpe fasciculata, involuta, basi confluentes, lateraliter concreta."

5. Hassallia? limbata *Hass.*

Plate LXVII. Fig. 6.

Char. "Filaments *thick, flexuous, æruginous, with a broad, pellucid margin, loosely interwoven in a dense dull æruginous green stratum.*" — Grev.

O. limbata Grev. Crypt. Flor. Syn. p. 40. and t. 246. (*O. rupestris*). *Scytonema æruginco-cinereum* Kützing, Phyc. General. p. 214. *Ocellatoria limbata* Harv. in Hook. Brit. Flor. p. 375.; also in Manual p. 164.

Hab. On perpendicular rocks, exposed to the trickling of water, Pentland Hills: *Dr. Greville.*

On first examining an authentic specimen of this plant, I was impressed with the idea that it ought to be referred to the genus *Scytonema*, but from not discovering branches on the filaments, I did not feel quite certain on this point. Kützing having made the species the type of his genus *Scytonema*, there can be but little doubt but that it really belongs to the family *Scytonemeæ*. "Plant covering the face of the rock for several inches together, and when old, peeling off in rather large pieces. Externally it is mostly of a dull and brownish green colour, but within more of a verdigris

green, differing in intensity in different parts; here and there gelatinous and semi-transparent. Filaments thick for their length, very flexuous, with a pellucid colourless limb, equal in breadth to the coloured, striated portion, which is of a pale verdigris green."—*Grev.*

24. SCYTONEMA *Ag.*

Char. "Branches *increasing by the protrusion and division of the central row of cells.*" — *Berk. in lit.*

Derivation. From σκυτος, *a skin,* and νημα, *a thread;* in allusion to the toughness of the filaments.

The genus *Scytonema* has hitherto evidently embraced the description of plants belonging to two distinct genera.

The above, therefore, is Mr. Berkeley's definition of the genus *Scytonema,* as very properly proposed to be restricted by that gentleman a considerable time ago. This concise definition briefly describes the essential character of the altered genus, but there are also others which serve to distinguish its species from those which have hitherto been associated with *Scytonema,* and which confirms the view adopted by Mr. Berkeley of the necessity of forming two genera out of those species. From the protrusion and division of the central row of cells, it follows that the branches should frequently be in pairs, and this is generally the case: the filaments, also flaccid, of nearly equal diameter, are rarely moniliform. The definition of the reconstructed genus *Scytonema* might stand more fully thus: —

Char. Filaments *flaccid, of nearly equal diameter.* Branches *usually in pairs, and formed by the protrusion and division of the central row of cells.* Cells *generally quadrangular, rarely if ever regularly moniliform.*

Kützing, in his "Phycologia Generalis," has removed one species from the genus *Scytonema, S. ocellatum,* and formed for it a new genus *Sirosyphon;* but still the genus *Scytonema* of Kützing does not in the most remote degree cor-

respond with the genus as defined by Mr. Berkeley or myself, neither does his genus *Sirosyphon* answer to the genus *Hassallia*, formed by Mr. Berkeley for those species hitherto associated with the genus *Scytonema*, but which the definition of that genus, as it at present stands, does not embrace.

The following is Kützing's definition of *Scytonema* :—

"Trichomata vagina duplici, firma crassiuscula colorata arcte inclusa ramosa; rami ex continuatione trichomatis interni et prolongatione vaginæ oriundi, non basi iis discreta. Spermatia ex articulis intumescentibus progenita."

In the genus as thus characterised, Kützing includes the following British species. *Scytonema ærugineo-cinereum* (*Ocellatoria rupestris*, Grev. Scot. Flor. Turf. 246.?), *S. myochrous*, *S. turfosum*, and *S. compactum*. Now out of these four species there is but one which could be received into the genus *Scytonema* of Mr. Berkeley, and that one is *Scyt. myochrous*. It is clear, therefore, that there is no correspondence between the genus *Scytonema* of Berkeley and that of Kützing.

1. Scytonema hibernicum *Hass.*

Plate LXVIII. Fig. 1.

Char. Filaments *of considerable diameter.* Cells *about as long as broad, issuing in pairs at right angles with the stems.*

Scyt. hibernicum Hassall, MS.

Hab. On a clayey bank, co. Antrim, Ireland: *Mr. Moore.*

Of this beautiful species I have seen but a single specimen. It was sent to me by Mr. Moore, with the name of *Scyt. ocellatum* upon it, with which plant however it has no affinity. The cells are of exactly the same form as in *Scy. myochrous*, from which it differs principally in being altogether larger.

2. SCYTONEMA MYOCHROUS *Ag.*

Plate LXVIII. Fig. 2.

Char. Filaments *of less considerable diameter, elongate, mostly decumbent and flexuous.*

Lyngb. t. 297. and *S. ocellatum* Lyngb. t. 28. *Conf. myochrous* Dillw. Conf. t. 19.; E. B. t. 1555. *Conf. mirabilis*, E. B. 2219. (not of Dillw.) *Scytonema contextum* Carmichael.

Hab. Various parts of Wales: *Mr. Dillwyn* and *Mr. Woods.* Neighbourhood of Bantry: *Miss Hutchins.* Crowborough Warren, and in Pressbridge Warren, near Wych Cross: *Mr. Jenner.* Dolgelly: *Mr. Ralfs.*

This species differs from the previous one only in being smaller in all its parts. I have no doubt of the correctness of *Scyt. contextum* as a synonym, having, through the kindness of Mr. Harvey, had an opportunity of examining an authentic specimen. Carmichael thus describes it: — "This species occurs in a thin, closely matted blackish fleece, of indeterminate extent. Filaments two or three lines in length, simple, or rarely furnished with one or two branches," (which are occasionally geminate, as in *S. myochrous*), "interwoven into an almost inextricable stratum. Sporidia, when visible, which rarely happens, globular and rather distant. Besides the comparative shortness of the filaments, and the more intimate contexture of the stratum, this species differs from *S. myochrous* in becoming, when dry, of a light greyish-green colour instead of black." — *Carm. MSS.*

25. PETALONEMA *Berk.*

Char. Frond *composed of flat, branched or simple filaments, the margins membranaceous and striate.*

Derivation. From πεταλον, *a leaf* or *lamina*, and νημα, *a thread*; in allusion to the singularly winged filaments.

1. PETALONEMA ALATUM.

Plate LXVIII. Fig. 6.

Char. Filaments *broadly membranaceous.*

P. alatum Berk., Glean. of Alg., p. 23. t. 7. fig. 2. *Oscillatoria alata* Carm. Grev. Crypt. Fl. 222.; Harv. in Hook. Br. Fl. 378.; Harv. in Manual, p. 168.

Hab. On wet calcareous cliffs, Appin: *Capt. Carmichael.* Oban: *Rev. M. J. Berkeley.* Aberdeen: *Dr. Dickie.*

This highly curious plant forms a brownish or chestnut-coloured stratum, subgelatinous. The filaments, which are irregularly branched, central, consist of a coloured thread, which is distinctly annulated, and a broad colourless striated sheath, obtuse at its extremity. The contrast between the coloured and uncoloured portions of the filaments, and the delicate striæ on the sheath, render this a very beautiful object.

26. ARTHRONEMA *Hass.*

Char. Filaments *simple, rarely branched? of equal diameter, divided into successive portions.*

Derivation. From *αρθρον, a joint,* and *νημα, a thread.*

It is not without some hesitation that I have ventured to constitute a new genus for the reception of this curious production, which could not consistently I think be allowed to remain with either *Scytonema* or *Hassallia.*

1. ARTHRONEMA CIRRHOSUM *Hass.*

Plate LXVIII. Fig. 7.

Char. Filaments *of considerable size, striæ close and evident.*

Scytonema cirrhosum Carm. *Tufts* widely spreading, *filaments* floating in bundles, spuriously? branched; *branches* beset with fragments towards the top." — *Carm. MS.*

Harv. in Hook. Br. Flor. p. 366.; Harv. in Manual, p. 155.

Hab. Borders of lakes at Lismore Island: *Captain Carmichael.*

"It occurs in continuous fleeces parallel to the water's edge, of a deep chestnut colour when lying flat, dark olive when floating. The fleeces are made up of small, contiguous fasciculi of interlaced filaments. The filaments are from half an inch to an inch in length, simple or spuriously (?) branched, and prolonged by successive adhesions of portions, seemingly of broken filaments, which at length coalesce and form a knot at the points of adhesion. The transverse striæ are close and conspicuous." — *Carm.*

Each filament, at regular distances, is obliquely divided: these divisions are not formed by "successive adhesion of portions," but by the partial separation into portions of a single filament, the investing membrane or sheath remaining entire.

Section ii. *Calothriceæ.*

"I have seen upon a *Calothrix*, gathered in the ponds of water proceeding from the overflowing of the Seine, secondary oblong branches formed, which at first sight presented no difference of organization with that of the principal tube. These branches presented transverse approximate internal divisions, and were filled with endochrome of a very pale green tint. Shortly after their appearance, I have seen the contents of these branches pierce the external envelope, which it left empty and transparent, and issue under the form of a tubular body, oblong, partitioned, obtuse at both extremities like the principal filament. Unfortunately I have not been able to follow their developement, because the filaments themselves have become destroyed, or covered with crystals resembling those of *Chætophora*." — P. 333.

Mr. Dillwyn, in his "Introduction to the British Confervæ," makes some remarks of the same nature in reference to *C. distorta.*

27. TOLYPOTHRIX *Kützing.*

Char. Filaments *of nearly equal diameter, tufted, tenacious.* Branches *few, continuous with the main filaments, annulated at the base.* Cells *indistinct, rarely moniliform.* Sporules *escaping at the extremities of the filaments.*

Derivation. From τολυπη, *wool,* and θριξ, *hair.*

Kützing, in his "Phycologia Generalis," has established the genus *Tolypothrix,* which I here adopt. In the genus *Calothrix* Ag. Kützing describes only *C. mirabilis,* a production which differs essentially and generically from the proper *Calothrices,* all of which Kützing refers to his new genus. A preferable arrangement I conceive would have been to have constituted a new genus for the single species *C. mirabilis,* and to have allowed the *Calothrices* to have remained in the genus in which they have been so long placed, and the nature of which is so well understood by algologists.

a. Branches *discrete.*

1. TOLYPOTHRIX PUNCTATA *Hass.*

Plate LXIX. Fig. 3.

Char. Filaments *somewhat irregular, very sparingly branched, diameter considerable.* Cells *not quite so long as broad, nucleated.*

Hab. Under a cascade, co. Wicklow: *Mr. Moore.*

This species is larger than *T. distorta,* and the filaments less uniform; the branches are rarely formed, and the cells punctated.

2. TOLYPOTHRIX DISTORTA *Kütz.*

Plate LXIX. Fig. 4.

Char. Filaments *elongated, bluish green, forming large tufts, mucous, somewhat rigid, branched.* Branches *erect, flexuous.*

Conf. distorta Dillw. t. 22.; E. Bot. t. 2577. *C. distorta* Harv. in Hook. Brit. Flor. p. 369.; Harv. in Manual, p. 158.

Hab. Adhering to sticks, stems, &c.; common,

This species forms tufts of from half an inch to an inch in height, of a dark green hue, which on drying becomes of an intense verdigris or blue green colour; the filaments are slender, and the branches elongated and simple.

3. Tolypothrix Berkeleyana *Carm.*

Plate LXIX. Fig. 5. ?

Char. Filaments *minute, bright grass green, flaccid, flexuous, tufted.* — Harv.

Calothrix Berkeleyana Harv. in Hook. Br. Fl. p. 367.; also in Manual, p. 157.

"Tufts scattered, about a line in diameter, of a vivid green colour. Filaments twenty to thirty in each tuft, radiating horizontally from a central point, exceedingly slender, flaccid, tapering to a hyaline point, variously curved or flexuous. It comes very near *C. confervicola;* but the filaments are much shorter and more slender, and possess nothing of the rigid, erect habit of that species." — *Carm. MS. cum icone.*

4. Tolypothrix nivea *Hass.*

Plate LXIX. Fig. 6.

Char. "Filaments *exceedingly slender, rigid, white, forming dirty yellow continuous tufts.*" — Harv.

Conf. nivea Dillw. t. c.; E. Bot. 2529. *Cal. nivea* Harv. in Hook. Brit. Fl.; also in Manual, p. 157.

Hab. In sulphur springs, Yorkshire and Durham: *Dr. Willan.* Near Darlington: *Mr. W. Backhouse.* Plentiful in sulphur springs, Llanwrtyd, and other similar springs in Great Britain: *Dillw.*

"Dr. Willan assures us that this species is found below the spring no further than as the water retains the sensible

sulphureous properties, as if the hepatic gas were necessary to its production and nourishment." — *Dillw.*

5. Tolypothrix rufescens.

Plate LXIX. Fig. 7.

Char. Filaments *minute, spreading in a thin slimy purplish stratum.*

Calothrix rufescens Carm.; Harv. in Hook. B. Flor. p. 368.; Harv. in Manual, p. 158.

Hab. On rocks under the spray of cascades, Appin: *Captain Carmichael.*

"Crust or stratum of indefinite extent, and so thin as to seem a mere discoloration of the rocks until the finger is passed over it, when a certain sliminess detects the presence of the plant. Filaments half a line in length, and so slender as to appear mere lines under the highest power of the compound microscope." — *Carm. MS.*

b. *Branches adherent to the main filaments.*

6. Tolypothrix Dillwynii *Hass.*

Plate LXVIII. Figs. 4, 5.

Char. Filaments *tufted.* Branches *subulate, adherent to the principal threads nearly their whole length.* Striæ *about a diameter from each other.*

Scytonema Dillwynii Harv. et Ralfs' MS.

Hab. Dolgelly: *Mr. Ralfs.* Moist rocks, co. Antrim: *Mr. Moore.*

This species was named by Harvey *Scytonema Dillwynii,* under the impression that it was the *Microcoleus? Dillwynii* of his "Manual," and the *Conf. vaginata* of Dillwyn, t. 99. which it is difficult to conceive from Dillwyn's description that it really is. I felt much inclined to place this plant by

itself in a distinct genus, and perhaps this would have been the correct course; it is, however, more naturally associated with the genus *Tolypothrix* than with *Scytonema*. It forms little tufts two or three lines in height.

28. CALOTHRIX.

Char. Filaments *of equal diameter, branched by apposition.*

Derivation. From *καλος, beautiful,* and *θριξ, a hair.*

1. Calothrix mirabilis.

Plate LXIX. Fig. 1.

Char. Filaments *tufted, æruginous, black, articulated.* Striæ *distant about the half of a diameter from each other, distinct.*

Conf. mirabilis Dillw. t. 96. *Calothrix atroviridis* Harv. in Manual, p. 159.; Harv. in Hook. B. Flora, p. 369.

Hab. On mosses and in small streams, rare. Stream which runs through the wood at Penllegare, near Swansea: *Dillwyn.* — *C. atroviridis* in spring wells, near Penzance: *Mr. Ralfs.* Aberdeen: *Dr. Dickie.*

Having had opportunities of examining, through the kindness of Mr. Dillwyn and Mr. Harvey, authentic specimens of *Conf. mirabilis* and *Calothrix atroviridis*, I have no hesitation in declaring that the two plants are identical. There is a close resemblance between *C. mirabilis* and *Lyngbya copulata*, which species ought not to be far removed from each other in a natural arrangement.

Fam. XIII. OSCILLATOREÆ.

The family of *Oscillatoreæ*, limited to the genera *Oscillatoria* and *Microcoleus*, is one of the most distinct and remarkable of the divisions of the *Algæ*. The majority of the species are characterized by the minuteness of their filaments, the equality of their calibre, and their mathematical rectitude or straightness; they are still further distinguished by the brevity of their cells, the ease with which these separate from each other, the wonderful rapidity of their growth, the surpassing brilliancy of their colours, and lastly, by a peculiar oscillation, upon which feature their generic name has been founded, but with regard to which I can myself perceive nothing extraordinary, although the phenomenon is certainly peculiar to this family — nothing indicative, as most suppose, of a sensitive or animal life. The explanation to be given of this oscillation of the filaments I consider to be partly of an external, and entirely of a physical character. It has been stated that the filaments of very many species of *Oscillatoria*, and indeed of all those which present the phenomenon of oscillation, are remarkable for their straightness or rectitude, which is due to a certain degree of elasticity belonging to them, and which leads to the effort on their part, whenever, as on being placed for observation on the field of the microscope, must be the case, they are bent or put out of a straight line, to recover that position which is natural to them. This elastic property of the filaments, currents almost imperceptible in the liquid in which they are immersed, and perhaps unequal attractions amongst the filaments themselves, are causes amply sufficient to explain any motion which I have ever witnessed amongst the *Oscillatoriæ*, and which motion I cannot help thinking to have been misunderstood and exaggerated to such an extent, as to throw around these plants an unnecessary degree of mystery.

Upon the reproduction of this family, and some others which follow, no very precise observations appear to have been made. Vaucher remarking the ease with which the cells or "rings" separated from each other, supposed them to be multiplied by means of these. This separation, however, is probably merely to be regarded as a preparatory step, the true reproduction being by means of zoospores.

Gerod Chantrans* makes some observations upon the reproduction of the *Oscillatoriæ*. He states that when an *Oscillatoria* has reached its complete developement, it emits from its cells a granulated powder, each grain of which increases insensibly until finally it becomes developed into a perfect plant. In this account, Gerod Chantrans has not swerved far from the truth.

The species of this family are found under very different circumstances; upon the moist earth, in stagnant, still, and running waters; in medicinal waters, and in such as are absolutely hot and almost boiling. They are, with very few exceptions, highly mucous to the touch, and in some kinds the filaments are imbedded in a mucous nidus.

The brilliancy of their colours has been noticed. The tints are various, shades of bright and beautiful greens, many presenting a metallic or æruginous cast, of violet, purple, dark brown and glossy black.

No description of a species can be considered perfect, unless it be taken from an examination of specimens, both in the recent and dried state, the characters not being identical in these conditions.

A monograph on this family, the result of two or three years' patient and careful observation, is much needed.

29. OSCILLATORIA.

Char. Filaments *simple, even, elastic, closely striated, and often lying in a mucous matrix.*

Derivation. From *oscillo*, to vibrate.

* Recherches Chimiques et Microscopiques sur les Conferves, &c. Paris, an x.

Kützing's definition is as follows: —

"Trichomata libera, basi vaginata, ex vagina longe prorepentia, vaginæ achromaticæ tenerrimæ, simplices, utrimque opertæ liberæ, nunquam coalitæ."

Kützing makes a genus for the reception of the *Oscillatoria autumnalis* Ag., of which *Conf. decorticans* of Dillw. is a synonym. The genus is as follows: —

Phormidium.

"Trichomata libera, basi vaginata, ex vagina prorepentia, vaginæ achromaticæ, simplices (non lamellosæ), apertæ, lateraliter in membranam plus minusve continuam coalitæ."

I can offer no opinion on this genus, but I cannot perceive in what the *Conf. decorticans* (Dillwyn) differs generically from other *Oscillatoriæ.*

a. Filaments *brittle.*

1. OSCILLATORIA LIMOSA *Ag.*

Plate LXXI. Fig. 2.

Char. Filaments *brittle, straight, large.* Stratum *rich dark green, glossy, and gelatinous.* Striæ *strongly marked and close.*

O. limosa Harv. Hook. Br. Fl. p. 374.; Harv. Manual, p. 162. (Not of Grev. Flor. Edin. p. 303.; or Hook. Scot. Fl. part ii. p. 79.)

Stratum of a rich dark and æruginous green colour, sending out from its edges long radii equally or in bundles; it is also glossy, even in the dried state. Filaments when recent of equal diameter, but in the dried condition they are seen to be variously twisted and furrowed, and the striæ to be much less conspicuous. The furrowing and consequent irregularity of diameter of the filaments in dried specimens, affords not unfrequently a distinguishing character between nearly allied species. Mr. Harvey remarks that this fine species is apparently alluded to by Dillwyn in his description of *Conferva*

fontinalis, t. 64.; but the figure is more like *O nigra*. In drying it adheres closely to paper. From *O. major* it differs in the much greater diameter of its filaments, and darker colour. It is therefore intermediate between these species.

2. Oscillatoria mucosa *Hass.*

Plate LXXI. Fig. 1.

Char. Stratum *gelatinous, dark, æruginous green, glossy.* Filaments *large.* Striæ *subdistant.*

Hab. Floating in a pond like a little dusky cloud; Stevenston: *Rev. D. Landsborough.*

This species agrees with the previous one in all its characters, save in the arrangement of the striæ. The filaments are of the same diameter, of the same gelatinous habit, and present the irregular and furrowed appearance when dried of *O. limosa:* the only difference between the two species is in the striæ, which are twice as distant in this as in *O. limosa.*

The only specimen which I have seen of this species is that sent me by the Rev. D. Landsborough. There can be no doubt entertained of its distinctness.

3. Oscillatoria cinerea *Hass.*

Plate LXX. Fig. 4.

Char. Stratum *of a dull æruginous green colour.* Filaments *large.* Striæ *close, very evident.*

Hab. In a pond on Stanstead Common, Essex.

This is a fine and well-marked species. The diameter of the filaments is equal to that of the two preceding *Oscillatoriæ*, but they are infinitely less mucous, and the stratum when dried is not in the least glossy, neither do the filaments collapse or become wrinkled in drying, but preserve the same equal diameter in the dried as in the recent state. The species, judging from Carmichael's description, seems to come near to the *Oscillatoria littoralis* of that observer.

4. Oscillatoria tenuis *Ag.*

Plate LXXII. Fig. 1.

Char. Stratum *rich dark green, very thin, gelatinous, with short rays.* Filaments *pale green, straight.* Striæ *subdistant, evident.*

Grev. Edin., p. 303.; Harv. in Hook. Brit. Flor. 374.; Harv. in Manual, p. 163. *O. limosa* Hook. Scot. ii. p. 79. *Conf. limosa* Dillw. t. 20. *O. viridis* Johnst. Berw. Flor. p. 264.

Hab. Common in ditches.

"In muddy ditches, at first resting at the bottom, but gradually rising in bullated strata to the surface, common; *stratum* extensive, glossy when dry, in which state it fully preserves its colour. Filaments, of half the diameter of those of *O. limosa*, pale green; striæ distant and indistinct. It adheres strongly to paper." — *Harv.* The stratum of this species exactly resembles that of *O. limosa*, and the filaments, like it also, contract somewhat in drying; they are, however, two or three times smaller; the striæ more distant, and not so strongly marked.

5. Oscillatoria cyanea *Ag.*

Char. "*Glaucous blue.* Filaments *simple, entangled, cylindrical, even, with a deciduous coat.* Joints *obsolete, about as long as broad.*" — Sm.

Harv. Hook. Br. Fl. p. 374. *Conferva cyanea*, E. B. t. 2578.; Harv. Manual, p. 163.

Hab. Damp walls on the inside of several Suffolk churches; at Icklingham and Hengrave; also in Lincolnshire: *Sir Thomas Gage, Bart.*

"On the wall it is conspicuous for its light sky-blue colour, like some sort of mucor. Under a high magnifier, and when moistened, it is found to consist of minute, even, simple, entangled threads, one five hundredth part of an inch in dia-

meter, coated with a frequently interrupted covering of a dull glaucous green hue, under which the thread itself appears of a lighter glaucous bluish colour, very even in thickness and surface, consisting of scarcely distinguishable joints, about as broad as they are long." — *Sm.*

6. Oscillatoria ærugescens *Drum.*

Plate LXXII. Fig. 2.

Char. Stratum *of a fine deep green, highly gelatinous; when dried, æruginous blue, and glossy.* Filaments *slender, opaque green.* Striæ *evident.*

Drummond, in Ann. Nat. Hist. vol. i. p. 1.; Manual of Brit. Alg. p. 163.

Hab. Lakes of Glaslough, co. Monaghan, Ireland: *Dr. Drummond.* Farnham: *Mr. Jenner.* Bottom of pools near Stocket, Aberdeen: *Dr. Dickie.*

"*Filaments* exceedingly slender, opaque green; conglomerated in large toughish glutinous masses, in sheltered, calm situations, and rarely floating on the surface; in more open exposures, broken into innumerable fragments, and suspended like cloudy flocculi in the water. *Striæ* numerous, at distances of about half a diameter from each other. *Oscillatory* movement often lively. *Colour* when dried, a beautiful æruginous blue; adheres strongly to paper, exhibiting a glossy surface. Filaments expanded by moisture so as to seem recent, and sometimes resuming the oscillatory motion." — *Dr. Drummond.*

This species may at once be distinguished when dried from all others by the peculiarly dense and waxen appearance of the stratum, which also exhibits numerous fissures. The filaments are smaller than those of *O. tenuis*, and the striæ closer. They are likewise brittle, and when dried break up into very short pieces, which are not of uniform diameter.

7. Oscillatoria pulchella *Hass.*

Plate LXX. Fig. 5.

Char. Filaments *thich, straight, brittle, vivid green.* Striæ *close, very conspicuous.*

Hab. Bottom of pools near Stocket, Aberdeen: *Dr. Dickie.* Cheshunt: *A. H. H.*

The filaments of this fine species are more robust than those of *O. virescens* and the striæ closer. The only other described species with which it could be confounded is *O. spadicea,* which it resembles in the closeness and strength of the striæ; but the filaments in *O. pulchella* are rather finer and much more brittle.

8. Oscillatoria virescens *Hass.*

Plate LXXI. Fig. 9.

Char. Stratum *terrestrial, of a light æruginous green colour.* Filaments *of considerable diameter, pale yellowish green straight, brittle.* Striæ *subdistant.*

Hab. Cheshunt, Herts: *A. H. H.* Between River Head and Chipstead, bankside: *Mr. Jenner.*

This would appear to be a distinct as well as a fine species. The filaments are longer than those of *O. tenuis,* and moreover preserve their diameter in drying. Striæ nearly a diameter of the filaments apart, conspicuous.

9. Oscillatoria thermalis *Hass.*

Plate LXXII. Fig. 3.

Char. Filaments *small, green.* Striæ *straight, brittle, subdistant, very evident.*

Hab. In a stream of hot water, Stevenston: *Rev. D. Landsborough.*

The filaments of this species are as slender as those of *O.*

terebriformis, but of a different colour, and the striæ are much more evident.

10. Oscillatoria splendida *Grev.*

Plate LXXII. Fig. 8.

Char. Stratum *bright æruginous or bluish green, thin, with short rays.* Filaments *arachnoid, straight or curved,* Striæ *wholly invisible.*

Grev. Flor. Edin., p. 304.; Harv. Br. Flor. 375.; Harv. Manual, p. 164. *O. membranacea, O. amphibia* and *O. elegans* Ag.

Hab. In tubs of water in the stove of the Botanic Garden, Edinburgh: *Dr. Greville.*

This is the most slender of all the *Oscillatoriæ*. The stratum exactly resembles in colour and appearance that of either *O. limosa* or *O. tenuis*, from which it may be immediately detected by the microscope. Agardh has described this species under no less than three different names, as I have ascertained from an examination of authentic specimens in the Herbarium of Sir W. J. Hooker.

11. Oscillatoria autumnalis *Ag.*

Plate LXXII. Fig. 7.

Char. Stratum *of a deep æruginous green, with a metallic lustre, very lubricous.* Filaments *very slender.* Striæ *subdistant.*

O. autumnalis Ag. Syst. p. 62.; Grev. Flor. Edin. p. 305.; Harv. l. c. p. 376.; Harv. Manual, p. 165.

Hab. Appin: *Carmichael.*

The filaments of this species are very slender, not being more than twice the diameter of those of *O. splendida*. They cohere closely, and are usually very much broken when examined under the microscope. Striæ not very evident, subdistant.

12. Oscillatoria muscorum *Ag.*

Plate LXXII. Fig. 12.

Char. Stratum *dark æruginous green, shortly radiating, creeping over mosses.* Filaments *thickish, pale blue green.* Striæ *distant.*

O. muscorum Ag. Syst. p. 375.; Harv. Hook. Br. Flor. 365.; Manual, p. 164.

Hab. On *Hypnum ruscifolium* in rapid streams: *Captain Carmichael.*

"Stratum three or four inches in extent, closely interwoven with the branches and leaves of mosses, of a bluish green colour, and slightly lubricous. Filaments a line or two in length, variously curved, and radiating. Striæ at the distance of a diameter from each other." — *Carm. MS.* Filaments brittle, about equal in diameter to those of *O. turfosa,* and when examined in the dried state, usually found to be much broken up, with the striæ all but invisible.

b. Filaments *flexuous, coriaceous.*

13. Oscillatoria corium *Ag.*

Char. "Stratum *thick, subcoriaceous, opaque, dull brownish, streaked with pale green.* Filaments *yellowish, slender.* Striæ *indistinct, distant.*" — Harv.

O. corium Grev. Flor. Edin., p. 303.; Harv. Hook. Br. Fl. p. 377.; Harv. Manual, p. 166.

Hab. On the rocky bottoms of alpine rivulets.

"Stratum thick, tough, dull brownish; occasionally streaked with pale green, which in some varieties is the prevailing colour, slightly glossy when dry; filaments slender. In some situations it radiates in fascicles from its whole upper surface; in others, it is found almost denuded of radii, and forming a compact leathery stratum." — *Harv.*

14. Oscillatoria turfosa *Carm.*

Plate LXXII. Fig. 6.

Char. Stratum *pale verdigris green, glaucous, with an ochraceous substratum.* Filaments *slender, curved.* Striæ *distant.*

O. turfosa Harv. in Hook. Br. Flor.; Harv. in Manual.

Hab. On floating sods in old turf pits. Appin: *Capt. Carmichael.* Near Dolgelley: *Mr. Ralfs.*

"This species grows in a thick intensely green layer, over a tough slimy ochre-coloured substratum. It entirely enveloped the sods, some of which were a foot and a half in diameter. *Filaments* very slender, more or less curved, and mostly hyaline at the point." — *Carm. MS.* The filaments are nearly equal in size to those of *O. muscorum*, from which, however, they may be distinguished by their greater tenacity and length. Sometimes the endochrome is discharged from a portion of a filament.

15. Oscillatoria subfusca *Vauch.*

Plate LXXII. Fig. 9.

Char. Stratum *dull greyish brown, somewhat streaked with green; soft, green, fragile.* Filaments *very slender.* Striæ *inconspicuous.*

O. subfusca Vauch. Hist. des Conf.; Lyngb., t. 26.; Harv. in Br. Flor. 377.; Harv. in Manual, p. 166.

Hab. Rocks and stones in sub-alpine rivulets.

Stratum "soft, slimy, void of tenacity, wrinkled; of a dusky grey colour." — *Carm.* It differs from *O. corium* "chiefly in being more gelatinous and fragile." — *Harv.* The filaments are very slender, long, much curved. Striæ in the dried specimens wholly invisible.

16. Oscillatoria violacea *Johnst.*

Plate LXXII. Fig. 10.

Char. "Mass *gelatinous, dark purple.* Filaments *very slender, straight, without perceptible, transverse striæ, laid on a thin, compact, greenish substratum.*" — Johnston.

O. violacea Johnston, Berw. Fl. p. 264.; Harv. in Hook. Br. Flor. p. 377.; Harv. in Manual, p. 166. *Oscillatoria rubiginosa* Carmichael, MS.

Hab. Rapid streams near Berwick upon Tweed: *Dr. Johnston.* On stones in the bottoms of rivers, co. Antrim: *D. Moore.* Appin: *Capt. Carmichael.*

When dry, the filaments of this species assume a blackish green cast, with an evident gloss. The filaments are thicker than those of *O. subfusca,* but do not, like those of that species, preserve their calibre in drying: they are also more brittle. Striæ in the dried specimens almost invisible, at a distance usually of about two diameters from each other. Dr. Johnston considers this to be the "*Conferva mucosa confragosa rivulis innascens*" of Dillenius.

17. Oscillatoria rupestris *Ag.*

Plate LXXII. Fig. 11.

Char. Stratum *blackish green, thick, opaque, extremely tough.* Filaments *rigid, brittle.* Striæ *almost imperceptible, at distances of about half a diameter.*

Ag. Syst. p. 63.; Harv. Hook. Brit. Fl. p. 377.; Harv. in Manual, p. 166. *O. tenax* Carm. MS.

Hab. On the precipitous face of cascades. Appin: *Capt. Carmichael.*

"Stratum extensive, slimy, remarkably tough and elastic, black on the surface, ash-coloured underneath: when dry blackish green. Filaments pale green, straight, or variously curved, radiating, but not equally in all directions." — *Carm. MS.* The dried stratum of this species resembles in colour

that of *O. muscorum*, than which, however, it is much more tough and elastic: the filaments likewise are much smaller. They are intermediate in diameter between those of *O. subfusca*, and *O. violacea*, differing also from both in some other respects. They are more brittle than those of *O. subfusca*, though like those of that species they preserve their diameter in drying, which is not the case with *O. violacea*. The striæ are close, and tolerably evident.

18. Oscillatoria spadicea *Carm.*

Plate LXXI. Fig. 5. and Plate LXXII. Fig. 5.

Char. Stratum *very thin, spreading.* Filaments *yellowish brown, thick, variously curved and twisted.* Striæ *conspicuous, and very close.*

O. spadicea Harv. Hook. Brit. Fl. p. 378.; Harv. in Manual, p. 167.

Hab. On damp mossy earth; rare. Appin: *Capt. Carmichael.* Ireland: *Mr. Moore.* Cheshunt: *A. H. H.*

"It occurs in a very thin dark green stratum, spreading to the extent of several feet, and is hardly to be distinguished from the mossy earth on which it grows. Filaments short, straight, curved, or spirally twisted, radiating in all directions, and possessed of all the movements peculiar to the tribe."—*Carm.*

c. Stratum *blackish*; filaments *brittle, not coriaceous.*

19. Oscillatoria nigra *Vauch.*

Plate LXXI. Fig. 3.

Char. Stratum *black; when dry bluish black, with long radii.* Filaments *pale bluish green, thick.* Striæ *very distinct and close.*

Hook. Scot. ii. p. 79. *Conf. fontinalis* Dillw. t. 64. *O. limosa*, Grev. Edin. p. 303. *O. nigra* Harv. in Manual, p. 165.

Hab. Ditches and ponds; common.

" Stratum extensive, blackish, with a shade of green; when dry, blue black, very rapid in its growth and sending out long vividly oscillating rays. Dillwyn's figure of *Conferva fontinalis* answers to this species pretty correctly." — *Harv.*

20. Oscillatoria contexta *Carm.*

Plate LXXI. Figs. 7. 4. 6.

Char. Stratum *glossy black, strongly striated.* Filaments *somewhat thick, pale green.* Striæ *subdistant, evident.*

O. contexta Harv. Hook. Brit. Fl. p. 376.; Manual, p. 165.

Hab. On moist ground. Appin: *Capt. Carmichael.* Cheshunt: *A. H. H.* Sussex: *Mr. Jenner.*

" Stratum of indefinite extent, three feet and upwards, exceedingly thin, and peeling off in large flakes in dry weather, of a deep but shining black colour, scored or striated in all directions. These striæ are caused by thick fasciculi of filaments, shooting out either parallel to or across each other, changing their course from time to time, and sending off lateral fasciculi. The filaments are rather thick, about a line in length, straight, or variously curved, of a greyish green colour, and they radiate with great rapidity. A portion of the stratum, not more than a line in diameter, placed in a watch-glass filled with water, overspread the whole area of the glass with filaments in the course of a night." — *Carm. MS.* This is a very distinct as well as fine species. The gloss of the stratum is equal to that of satin, and the filaments are in calibre not less than those of *O. tenuis*, from which species it is distinguished chiefly by its colour. The filaments do not contract in drying.

21. Oscillatoria Carmichaeli *Hass.*

Plate LXXI. Fig. 8.

Char. Stratum *black, destitute of gloss, thin, brittle.* Fila-

ments *slender, straight, brittle.* Striæ *subdistant, scarcely perceptible.*

O. nigra Carmichael, MS.

This species differs only from the following in the absence of gloss on the filaments; a difference which is, in all probability, of specific importance.

22. Oscillatoria terebriformis *Ag.*

Plate LXXII. Fig. 4.

Char. Stratum *terrestrial, bluish black, glossy.* Filaments *slender, straight, brittle.* Striæ *scarcely evident.*

O. terebriformis Ag.

Hab. Marshy places, Aberdeen, Nov. 1839: *Dr. Dickie.* Sussex: *Mr. Jenner.* Notting Hill: *A. H. H.*

A very abundant species.

23. Oscillatoria decorticans *Grev.*

Plate LXXI. Fig. 10.

Char. "Stratum *smooth, glaucous green, membranaceous.* Filaments *very slender, curved, pale bluish green.* Striæ *distant.*"—Harv.

Grev. Flora Edin. p. 304. *C. decorticans* Dillw. t. 26.; Harv. Manual, 164.

β *corticola.*—Stratum *blackish green.* See Pl. LXXI. fig. 4. *O. corticola* Carm. MS.

Hab. Damp walls, rotten timber, often on pumps, &c. Common. —β "on the trunk of an old sycamore where the rain water trickled down:" *Capt. Carmichael.*

Stratum membranaceous, not very gelatinous, peeling off in large flakes, and imperfectly adhering to paper; filaments very minute. I strongly suspect that the *O. contexta* of Carmichael is identical with Greville's *O. decorticans*, the β variety is altogether different.

d. Filaments *brown, brittle, not coriaceous.*

24. OSCILLATORIA DICKIEI *Hass.*

Plate LXXII. Fig. 13.

Char. Stratum *light chestnut, gelatinous, glossy.* Filaments *long, straight, brittle, rather thick.* Striæ *visible, subdistant.*

Hab. Pools of fresh water near the sea, Aberdeen: *Dr. Dickie.*

The colour of this species is so peculiar as at once to distinguish it from all others which have been described. This colour is preserved in drying; the filaments are of nearly the same diameter with those of *O. tenuis*, but they preserve their calibre when dried. Several fine specimens of this plant were sent me by Dr. Dickie, and which have undergone no change since they have been in my possession, now some weeks.

e. Filaments *collected into close erect tufts.*

In the species of this division of the genus there would appear to be an evident transition to *Rivularia*, the filaments in one, *O. lucifuga*, and perhaps in the others, being subulate, and which circumstance induced me, as well as its erect habit, to place that species in the genus *Rivularia*. I am now satisfied that it should either remain in the division of the genus *Oscillatoria* in which it has been placed by Mr. Harvey; or that Kützing's *Symploea* ought to be adopted for the reception of the species of this division of *Oscillatoria*. Kützing thus defines the genus:

Trichomata adscendentia vaginata in fasciculos erectos, basi confluentes, coalita; vaginæ ex membrana simplicima, hyalina, (nec striatæ nec lamellosæ) formatæ.

25. OSCILLATORIA FRIESII *Ag.*

Char. Stratum *bright green, bristling with the elongated, erect, tooth-like fascicles of filaments.*

Scytonema Bangii Lyngb. Dan. t. 28. *Oscillatoria Bangii* Carm. MS.; Grev. Edin. p. 303. *O. Friesii* Harv. Hook. Brit. Fl. 373.; Harv. in Manual, 162.

Hab. On mosses in shady subalpine situations, near Edinburgh: *Dr. Greville.* Appin: *Capt. Carmichael.* Killarney: *W. H. Harvey.* Co. Kerry: *Mr. Andrews.*

"Stratum two or three inches broad, bright æruginous green. Filaments closely interwoven into erect, elongated, tooth-like fascicles, an inch or more in height, pale green; under the microscope annulated within, with a broad limb or border. Well marked by its erect spinulose habit." — *Harv.* The filaments in the dried state are flaccid, long, and apparently of equal diameter. Striæ scarcely conspicuous, rather close.

26. Oscillatoria lucifuga *Harv.*

Plate LXV. Figs. 5, 6.

Char. Stratum *blackish green, bristling with minute tooth-like fascicles of filaments.* Filaments *subulate.*

Calothrix lucifuga Carm. MSS.; Harv. Hook. Br. Flor. p. 373.; Harv. Manual, p. 162.

Hab. "On the decayed trunk of an alder, lying in a ravine, and buried under a heap of rubbish," at Appin: *Capt. Carmichael.*

"*Stratum* spreading, dull, blackish green, bristling all over with minute erect fascicles about one-third of a line high. Filaments thickish, flexuous, strongly agglutinated together, annulated within, pale yellowish. Almost like the last species in miniature" (*Harv.*), of which it may be but a variety.

27. Oscillatoria tenuissima *Ag.*

Char. "*Dark green, ascending, tufted.* Filaments *simple, cylindrical, even, without any visible joints.*" — Harv.

O. tenuissima Sm., Eng. Bot. t. 2584.; Harv. in Hook. Br. Fl. 373.; Harv. in Manual, p. 162.

Hab. In the celebrated warm waters of Bath, spreading rather unequally in broad velvet-like patches, of a dark green colour: *Rev. H. Davies.*

" The irregularity of its appearance arises from the filaments being collected together into little ascending tufts, apparently rooted in the muddy deposit of the water. Each tuft proves, on examination, to consist of simple uniform even filaments, crowded together and quite pellucid, and equally destitute of joints and branches: their diameter is not more than the eighth or tenth thousandth part of an inch." — *Sm.*

30. MICROCOLEUS *Desmar.*

Char. Filaments *simple, straight, brittle, closely striated, in bundles, and enclosed within broad, membranous, and branched sheaths, from the apices of which they protrude.*

Chthonoplastus Kützing, Phyc. Gener. p. 197.

Derivation. From *μικρος, small,* and *κολεος, a sheath.*

This is an exceedingly beautiful and interesting genus; the younger branches or sheaths usually enclose but two or three filaments, while the older contain as many as fifty or sixty: it is difficult to conceive in what way the filaments become multiplied within the sheath, unless it be by a longitudinal division of them.

1. MICROCOLEUS REPENS *Harv.*

Plate LXX. Fig. 3.

Char. Fronds *terrestrial, decumbent, radiating, branches diverging, curled and twisted, gradually tapering to the extremity.* Filaments *large.* Striæ *subdistant, evident.*

Oscillatoria chthonoplastes β Harv. in Hook. Br. Fl. ii. p. 373. *Oscillatoria repens* Ag. Syst. p. 61. *Conf. vaginata,* Eng. Bot. t. 1995. *Vaginaria vulgaris* Gray, Br. Fl. i. p. 280.

Hab. "On the naked soil by road-sides, frequent:" *Harv.*

"This forms a dull green decumbent slimy stratum. The frond consists of numerous curled branches, diverging from a centre in a starry manner, and gradually tapering from a broad base to a fine point, containing numerous deep green filaments, which radiate and oscillate from the tips, and on laceration issue in bundles."—*Harv.*

2. MICROCOLEUS ANGUIFORMIS *Harv.*

Plate LXX. Fig. 1.

Char. Filaments *smaller than in the preceding species.*

M. anguiformis Harv. MSS.

Hab. Saltwater marshes.

This, although a very distinct species, is a doubtful freshwater production, and perhaps had better to have been altogether omitted from this work. The *Algæ* of our saltwater marshes require a separate study.

3. MICROCOLEUS GRACILIS *Hass.*

Plate LXX. Fig. 2.

Char. Filaments *very slender.*

Hab. Near Aberdeen: *Dr. Dickie.*

This is another salt marsh *Microcoleus*. I detected it amongst some *Algæ* sent me by Dr. Dickie. It is a distinct and pretty little species.

"Plants, as well as animals, excite the curiosity and interest of the observer, first, by diversities, which distinguish parts and properties and species; and by similitudes, which lead to the assemblage of species into groups, or genera and classes, &c.: secondly, by grace or beauty of form or colour; thirdly, by analogies, or affinities of relation, traceable, more or less remotely, throughout all the works of the Creator."—*Duncan.*

Fam. XIV. RIVULAREÆ.

Char. Frond *usually gelatinous, lubricous, and definite, in which are embedded* filaments *often flagelliform, simple, or spuriously branched, hilted below, the* hilts *being formed of an enlarged cell, connected to the filaments by a narrow neck, and filled with endochrome.* Sheaths *in which the filaments are enclosed, sometimes saccate below, above attenuated and open.*

No very exact observations have as yet been made upon the reproduction of this family. Do not the enlarged cells which terminate the base of the filaments correspond in function with those of the *Nostochineæ?* In the setigerous elongation of the filaments a resemblance to *Chætophora* is manifested. Certain species exhibit a relation to the *Scytonemeæ.*

31. RIVULARIA.

Section i. *Rivularia* Roth.

Char. Frond *wart-shaped, rarely encrusting, coriaceous.* Filaments *close, set firmly, adherent, spuriously branched, radiating.*

Linkia Lyngb.

1. Rivularia Pisum *Ag.*

Char. Frond *globose, smooth, shining, dark green.* Filaments *dichotomous, firmly united.*

Harv. in Hook. Br. Fl. vol. ii. p. 392.; Berk., Glean. Alg. t. 2. p. 2.

Hab. On aquatic plants in subalpine streamlets, Appin: *Captain Carmichael.* Cheshunt Common: *A. H. H.*

"*Fronds* a line in diameter, scattered or confluent, of a dark green colour and fleshy firmness. *Filaments* radiating from the base, dichotomously branched and alternate, the apices free." — *Carm.* I have no hesitation in referring all the British specimens which I have seen of this species to *Rivularia botryoides*, and these again to *R. granulifera*, which species I consider *R. Pisum* to be in the earliest period of its developement, and *Rivularia botryoides* that species in the middle period of its growth.

The following is Carmichael's description of *R. botryoides*, which, like the preceding, is found attached to stones, &c., in streamlets.

"*Fronds* about a line in diameter, hemispherical, wrinkled and cartilaginous, scattered or running together like a bunch of grapes. *Filaments* cohering firmly, obscurely striated, dichotomous. *Colour*, when fresh, black; on drying, darkly ferruginous." — *Carm.*

2. Rivularia granulifera *Carm.*

Plate LXV. Figs. 1. 4.

Char. Frond *large, convex, becoming hollow underneath, fleshy, lubricous, brownish olive, often including stony particles, never petrified.* Filaments *slender, firmly adherent, furnished with a broad sheath.*

Harv. in Hook. Br. Fl. p. 393.; in Manual, p. 151.

Hab. On cliffs exposed to the trickling of water, common, annual, Appin: *Captain Carmichael.* — Var. *botryoides* in streamlets, attached to rocks and stones, co. Antrim: *Mr. Moore.*

"*Fronds* from a line to half an inch in diameter, often confluent, convex, and at length concave underneath, fleshy, dusky olive green, and extremely slippery. *Filaments* rather thick, repeatedly dichotomous. In the substance are generally enclosed a number of stony particles. This species comes nearest in size and form to *R. calcarea*, but is never like that petrified with calcareous matter; and it is moreover

an annual plant, whereas the other exists for several years." — *Carm.*

A microscopical examination of these two plants will not only make it evident that the two are specifically distinct, but also most probably generically so.

Section ii. *RAPHIDIA* Carm.

Char. Frond *gelatinous, subglobose, bullated.* Filaments *few, flagelliform, simple, moniliform within, scattered through the gelatine, or radiating from a central point.*

1. RAPHIDIA ANGULOSA *Hass.*

Plate LXIV. Figs. 1. 4.

Char. Fronds *gregarious, roundish, gelatinous, hollow, of a bright chestnut colour when recent, changing to dark olive in drying.* Filaments *large, often produced into a long and curved setigerous point.* Sheath *broad, often angular.*

Rivularia angulosa Roth, Harv. in Hook. Br. Fl. p. 394.; and in Manual, p. 153. *Ulva pruniformis,* E. B. t. 968. *Raphania natans* Carm. MSS. cum icone.

Hab. Attached to aquatic plants in ponds and still waters, or floating on the surface, Appin: *Captain Carmichael.* In a pond on the common east of Lewes and Burwash Road, near Easton Green: *W. Borrer,* Esq. Swansea: *Mr. Ralfs.* Cheshunt Marshes: *A. H. H.* Near Cascades, co. Antrim: *Mr. Moore.*

"*Fronds* gregarious, often confluent, one fourth to three fourths of an inch in diameter, roundish, gelatinous, vesicular, and when detached, rising to the surface of the water with the velocity of an air-bubble. *Filaments* at the distance of 4 or 5 diameters from each other, radiating in all directions from the centre of the vesicle; rising from a colourless globule, inflated for about one-third of their length, thence tapering to a long slender often curved point. Internal mass moniliform, occupying about one half the diameter of the inflated part of

the filament. *Colour* pale chestnut, inclining to olive." — *Carm.*

2. RAPHIDIA VIRIDIS *Hass.*

Plate LXIV. Figs. 3. 2.

Char. Frond *very mucous, soft.* Filaments *small, elongated.* Sheath *not evident.*

β *marginata.*—Filaments *rather smaller.* Sheath *evident.*

Hab. Near Manchester: *Mr. Sidebotham.* Aberdeen: *Dr. Dickie.*

This *Raphidia* is very distinct. It was sent me by Mr. Sidebotham of Manchester put up in fluid. The filaments are not one half so large as those of *R. angulosa*, but much longer; the sheath in it could not be detected. In the variety β the sheath was quite apparent, and I at first was induced to regard it as altogether different: it is safer however to consider it merely as a variety of *R. viridis*, or as that species in its perfect condition, the sheath in the specimen sent by Mr. Sidebotham, and which had been put up some time in fluid, having probably become decomposed.

Section iii. *LITHONEMA* Hass.

Char. Fronds *indefinite, truly ramose.* Bases *of the* filaments *not manubriated.* Filaments *petrified.*

Derivation. From λιθος, *a stone*, and νημα, *a thread.*

1. LITHONEMA CALCAREUM *Hass.*

Plate LXV. Fig. 2.

Char. Fronds *large, orbicular, convex, afterwards aggregated into a broad spongy crust zoned within, at length petrified.* Filaments *slender, adherent, and dichotomously branched.*

R. calcarea Sm., E. B. t. 1799.; Harv. in Hook. Br. Fl. p. 392.; also in Manual, p. 150.

Hab. On rocks and stones in streamlets and the borders of subalpine lakes.

"*Fronds* one fourth or half an inch in diameter, circular or slightly convex, sometimes greenish, but oftener of a dark chestnut colour. After a time, they run together into a flat spongy crust, of indefinite size. On the smooth face of a rock exposed to the trickling of water, I found a sheet of it upwards of a foot in diameter. When broken the crust appears zoned within, so as to indicate the age of the plant, each zone being equal to a year's growth. At this age, it is always more or less stony, from the absorption of calcareous matter."—*Carm.*

2. LITHONEMA CRUSTACEUM *Hass.*

Plate LXV. Fig. 3.

Char. Crust *very thin, widely spreading.* Filaments *attenuated at the base, fastigiately branched above the middle.*

Rivularia crustacea Carm. MS. *R. crustacea* Harv. in Hook. Br. Fl. p. 393.; also in Manual, p. 151.

Hab. On rocks exposed to the spray of cascades, in the hill streams at Appin: *Captain Carmichael.*

"*Crust* of no determinate extent, extremely thin and slimy, black. *Filaments* one fourth of a line in length, attenuated at the base, fastigiately branched above the middle of an olive green colour."—*Carm.*

This species, although decidedly congeneric with *L. calcareum*, may at once be distinguished from it by the fastigiate division of its filaments.

"If you detect any mistakes of mine, I rely on your superior knowledge to excuse them; for who has ever avoided errors in the wide-extended field of Nature? Who is furnished with a sufficient stock of observations? I shall be thankful for your friendly corrections, I have done what I could myself."—*Linnæus to Haller.*

Fam. XV. NOSTOCHINEÆ.

The *Nostochineæ* form one of the most natural and beautiful of the families of freshwater *Algæ*. The filaments are simple, of uniform diameter, elegantly moniliform, resembling strings of pearls, in the highest degree flexible, and of exceeding lubricity. The species of which it is composed naturally arrange themselves into two divisions: in the one the filaments are free, and in the other imbedded in a mucous matrix, which sometimes assumes a definite form.

At intervals, in the course of the filaments, are observed cells larger than those which compose the thread itself: these, in the genus *Anabaina* are more or less of an oval or elongated form; while in the genus *Nostoc* they are exactly spherical. They are generally supposed to be connected with reproduction; but hitherto no precise observations have been made upon them. In most, and perhaps in all the species of *Nostoc*, many of these enlarged cells are scattered singly and detached throughout the mucous matrix: they have doubtless become separated from the filaments of which originally they formed a link.

If a *Nostoc* in the first period of its developement be examined, it will be observed to consist of a single moniliform thread, short, and but little curved, immersed in a mucous nidus. In each of the fully developed specimens of most of the *Nostocs*, however, threads innumerable present themselves. Now the question arises, in what way are those threads multiplied? First, and chiefly I conceive, by the separation or dislocation of the enlarged cells, whereby each filament is divided into other shorter filaments; and in the second place, probably by the growth of those vesicles themselves; but on this point nothing positive is known. Independently of these two modes of multiplication of the threads in each frond, no other conceivable method exists. The filaments in every example of a

true *Nostoc*, whether young or old, present one uniform diameter; there are no gradations of size. It cannot therefore be supposed that the threads are increased in number by the effusion of the minute contents of the cells.

The multiplication of the threads in a frond having been as it seems to me satisfactorily accounted for, the manner of the formation of new fronds remains to be determined. When a *Nostoc* has arrived at the full and last period of its developement, the pellicle formed by the inspissation of the mucous matrix bursts: the mucous contents and the filaments are effused: these last become disarticulated, so as to form short fragments, each of which retains about it a portion of mucus, so that in this state it corresponds with a *Nostoc* in the first period of its developement. In this mode of multiplication, remarkable as it is, there is nothing generically peculiar. A *Conferva* multiplies itself occasionally by the disarticulation of the filaments. The only difference between the case of the *Nostoc* and the *Conferva* is, that the process in the first is natural, and in the second artificial. While, however, the separation of the primary filaments accounts amply and satisfactorily for the multiplication, not only of the threads of a frond, but also for the increase of a number of the fronds themselves, it falls short of explaining the first developement of the first thread. The species of the genus *Nostoc*, like the freshwater *Algæ* in general, are short-lived: in the course of a few months they pass through the stages of their developement; they die, disappear; the filaments themselves are destroyed; and then are seen no more until the advent of another season. It is plain, therefore, that the true mode of reproduction of the species of this family is something more than a mere separation of the filaments into fragments. It is now, that in my view we learn the real nature of the enlarged vesicles: these are the true reproductive bodies, at the season not proper for their developement, lying concealed in the earth, awaiting their appointed time to start into growth, activity, and life — all else of the plant, the mucus and the filaments, utterly perishing.

In the "Annales des Sciences Naturelles," third series,

tome ii., there are some interesting observations on the reproduction of *Nostoc verrucosum* by M. Gustave Thuret, of whose accurate and skilful researches I have already had occasion to avail myself in the Introduction.

"When the plant has arrived at its full developement, the external pellicle, formed by the thickened mucilage, breaks, and permits the escape of the green jelly, which is composed of mucilage and threads. These last scatter themselves in the water the more easily, that they are endowed at that time with a spontaneous motion, analogous to that of the *Diatomaceæ*. This curious phenomenon has been already observed by Vaucher, who believed he had found it, although much more evident in all the other *Nostocs*. In spite of the assertion of that conscientious observer — in spite of the earnestness with which he sought to generalise this fact (Hist. des Tremelles, p. 215. et suiv.), it is difficult to compare movements at least equivocal, with mobility so evidently spontaneous, which the threads of the *Nostoc verrucosum* possess. Perhaps it is not without some interest to remark on this subject, that the spontaneous movements, the locomotion, are again met with under different forms, in the *Algæ*, which, like the *Nostocs*, live in running waters — in the *Oscillatoriæ*, in the spores of *Vaucheriæ*, the *Confervæ*, &c., and that this faculty appears to be a condition of their station.

"To observe well this phenomenon in the *Nostoc verrucosum*, the most simple way is to place in a plate filled with water some fine specimens freshly gathered. At the end of two or three days the external skin breaks, the threads expand in the water, and form at the bottom of the plate, or on the surface of the liquid, a green scum, nearly like that of the *Oscillatoria*. If then you have recourse to the microscope, you observe that the threads, originally very long, and winding in a thousand ways, are divided into a number of fragments of unequal lengths, all nearly straight, or scarcely bent, which move in the direction of their lengths, and seem to creep upon the surface of the object glass. The larger globules are detached and immoveable; no increase of magnifying power or mode of clearing, no re-agent, no

coloured infusion betrays the presence of vibratile ciliæ; and we cannot believe that the threads turn on themselves, because the granulations of the green matter do not change place during the progression. I have seen threads of three seeds move, but never a single seed. If you continue to observe for some days, you will see the thread become immoveable, increase in size, at the same time develope the mucilage with which they are surrounded as with a transparent sheath. Soon the seed enlarges considerably, and divides to form two others, but sideways, and not in the direction of the length of the threads.

"This formation is repeated many times, and it would seem natural to seek in this circumstance the origin of new threads. Unfortunately the increase of the number of grains, by diminishing the transparency, prevents one following the increase with the same facility. Their confused mass fills entirely the young *Nostoc*, which is developed in a very irregular manner, and takes a variety of forms. It is but later when the mucilage is most abundant, when the seeds are less crowded in the interior of the *Nostoc*, that you begin to distinguish the threads."

The *Nostochineæ* of the first section are mostly of a lively and exquisitely delicate green colour. They are wonderfully prolific, increasing to such an extent frequently as to impart their beautiful colour to extensive tracts of water, as also do occasionally certain species of *Oscillatoriæ*. One species described by Mr. Thompson, *Anabaina? spiralis*, and which I have named in honour of its discoverer, *Spirillum Thompsoni*, imparted its colour to the entire of an extensive lake, *Ballydrain*, which extends over about twenty acres of ground near *Belfast*.* The *Oscillatoria ærugescens* of Drummond in like manner imparted its rich green colour to an extensive lough in the north of Ireland, Glaslough, whose waters seemed greened as though by the reflection of trees.†

* For an interesting paper, by Mr. Thompson, on this *Alga*, see "Annals of Nat. Hist." vol. v.

† See Annals Nat. Hist. vol. i.

Leaving the limits of our own country, MM. Engelhardt and Treschel have described a minute *Alga*, which they have named *Oscillatoria rubescens*, and which tinges with a red colour the lake of Morat, in Switzerland, assuming sometimes a very beautiful arrangement, depending upon the motion of the water in which it is immersed.*

But it is not in fresh water merely that the productions of this family are found; they likewise have been noticed to occur in vast quantities in the sea, in different parts of the world; and it has been ascertained that the Red Sea owes its name to the periodical developement of a species of this family, the *Trichodesmium Ehrenbergii* Montagne. The name of Ehrenberg has very properly been appended to this species by Dr. Montagne, that illustrious naturalist being not merely the first to describe the species, but also the first to discover and record the important and wonderful fact that to a production in its individual parts so minute and insignificant, the Red Sea owes its name and appearance. This interesting discovery, however, of Ehrenberg was for many years overlooked, the account of it having been published in a work not devoted to natural history, but to chemical science, "Annals of Poggendorf." The following translation cannot fail to interest: —

"During the year 1823," observes M. Ehrenberg, "I made a stay of many months at Tor, upon the borders of the Red Sea, close to Mount Sinai. On the 10th of December I there saw the surprising phenomenon of the blood-red colouration of all the bay which forms the port of that city. The high sea, without the boundary of the corals, preserves its ordinary colour. The short waves of a tranquil sea bring upon the banks during the heat of the day a mucilaginous matter of a blood-red colour, and deposit it upon the sand, in such a manner as that in the course of a good half hour all the bay with the receding tide is surrounded with a red border of many

* Notice sur la matière qui a coloré en rouge le lac Morat, en 1825, par De Candolle, dans les Mémoires de la Société de Physique et d'Histoire Naturelle de Science, 1825, vol. ii. with fig.

feet in depth. I removed from the water some specimens with glasses, and carried them to a tent which I had near the sea. It was easy to perceive that the colouration was due to little tufts, scarcely visible, often greenish, and sometimes of an intense green, but for the most part of a deep red: the water upon which they floated was always colourless. This very interesting phenomenon, sufficient to afford a reason for the etymology of the name which this sea has received (an etymology up to the present time always buried in complete obscurity)—attracted all my attention, and I examined it at leisure with all the care of which I was capable. During many days I observed also the colouring matter with the microscope: the tufts were formed of little bundles of filaments of an *Oscillatoria;* they were fusiform and elongated, irregular, having rarely more than the diameter of a line, and were contained in a sort of mucilaginous sheath; but neither the filaments taken separately in each fleece, nor the fleeces themselves resembled each other. When the sun shines in the horizon, I observed, moreover, that these last maintained themselves upon the surface of the water in the glasses which I had brought with me, and that during the night, and when I shook the vessel, they reached the bottom. Some time afterwards they remounted to the surface.

"The phenomenon of the Red Sea was not permanent, but periodical. I observed it three other times, the 25th and 30th of December, 1823, and the 5th of January, 1824."

The same phenomenon of the colouration of the Red Sea, although on a scale infinitely more surprising, has occurred also more recently to other observers, especially to M. Evenor Dupont, a very distinguished advocate of the Isle of Mauritius, who also accurately determined, as did Ehrenberg previously the cause of this colouration, although he had no knowledge but that the discovery was entirely new to science, and which he found to be an *Alga,* which Dr. Montagne has ascertained to be identical with that described by the Prussian naturalist.

The letter of M. Evenor Dupont is so very circumstantial

and satisfactory, and corroborative of Ehrenberg's account, that its introduction cannot but be approved of. It is addressed to his friend M. Isidore Geoffroy-Saint-Hilaire.

" My dear Friend,

" You demand of me certain details in reference to the circumstances in which I gathered the *Cryptogamic* plant which I sent you from the Red Sea, and which you told me appeared a new species. They are as follow :—

" The 8th July last (1843) I entered into the Red Sea by the Strait of Babelmandel upon the steam-boat the Atalanta, belonging to the Indian Company. I demanded of the captain and the officers, who for a long time navigated in these latitudes (parages) what was the origin of this ancient name of the Red Sea; if it was owing, as some have pretended, to sands of that colour, or, according to others, to rocks. None of these gentlemen could reply to me; they never, they said, remarked any thing to justify this denomination. I observed then for myself as we advanced: whether the ship approached by turns the Arabian coast or the African coast, the red was in no part apparent. The horrid mountainous barriers which border the two banks were uniformly of a blackish brown, except where in some places the appearance of an extinct volcano had left long white streams. The sands were white, the reefs of coral were white also; the sea of the most beautiful cærulean blue. I had given up the hope of discovering my etymology.

" On the 15th of July the burning sun of Arabia awoke me suddenly by shining all at once, from the horizon without spot, and in all its splendour. I turned myself mechanically towards the window of the poop to seek a remnant of the fresh air of the night before the ardour of the day had devoured it. What was my surprise to behold the sea tinted with red as far as the eye could reach! Behind the ship, upon the deck, and on all sides I saw the same phenomenon.

" I interrogated the officers anew. The doctor pretended that he had already observed this fact, which was, according to him, produced by the fry of fish floating on the surface; the

others said that they did not recollect having seen it before. All seemed surprised that I should attach such interest to it.

"If it be necessary to describe the appearance of the sea, I should say that its surface was covered with a compact stratum of but little thickness, but of a fine texture, of a brick red, slightly tinged with rouge; sawdust of this colour, of mahogany, for example, would produce very nearly the same effect. It seemed to me, and I said at the time, that it was a marine plant. No one seemed of my opinion; so with a pail tied at the end of a rope I was able to gather, with one of the sailors, a certain quantity of the substance: this with a spoon I introduced into a white glass bottle, thinking that it would be the better preserved. The next day the substance had become of a deep violet, and the water had taken a pretty pink tinge. Fearing that the immersion would hasten the decomposition instead of preventing it, I emptied the contents of the bottle upon a piece of cotton (the same which I remitted to you). The water passed through it and the substance adhered to the tissue. In drying it became green, as you actually saw it. I ought to add, that on the 15th of July we were by the side of the town of Cosseir; that the sea was red the whole day; that the next, the 16th, it was the same until near mid-day, the hour at which we found ourselves before Tor, a little Arabian village, the palms of which we perceived in an oasis on the border of the sea, below the chain of mountains which descends from Sanai, even to the sandy shore. A little after mid-day, the 16th, the red disappeared, and the surface of the sea became blue as before. The 17th we cast anchor at Suez. The red colour had consequently showed itself from the 15th of July, towards 5 o'clock in the morning, up to the 16th, nearly an hour after mid-day; that is to say, during thirty-two hours. During this interval the steamboat, making eight knots an hour, as said the sailors, had traversed a space of 256 miles, or 85 leagues and a third.

"In the different works relative to Egypt and the Red Sea which I have had occasion to read, I do not recollect to have found mention made of a similar fact: it appears to me, nevertheless, but little probable that it has not been ob-

served by others. I reproached myself for not having questioned the Arabian pilot whom we had on board, and who for twenty years traversed that sea. This idea unhappily presented itself too late.

"If it should be in your opinion worth the pains, I would demand new observations of the surgeon or officers of the Atalanta, for it would be easy for me to write to them by way of Alexandria.

"Believe me, my dear Geoffroy, &c.

"EVENOR DUPONT."

Numerous other navigators and naturalists have noticed the colouration of different portions of the ocean, but these for the most part have not determined the exact nature of the cause, most of them attributing the phenomenon to minute animals. *Crustaceæ* and *Molluscæ*. Two English naturalists, in describing it, have distinctly stated the cause to be an *Alga*, the species of which, however, they did not determine. The first of these, Mr. Darwin, observed the phenomenon in the Atlantic ocean near Brazil, and not far from the Isles of Abrolhos. The other, Dr. Hinds, of H. M. ship Sulphur, encountered the same *Alga* at the same spot in which it was originally discovered by Mr. Darwin, and again observed it in the month of April 1837, while at anchor at Liberty, near San Salvador, upon the western coast of America, latitude 14° north. Mr. Hinds on both occasions remarked that the plant emitted a strong and penetrating odour, and many persons on board experiencing an irritation of the eyes, followed by an abundant secretion of tears, attributed the affection to the presence around the ship of the *Alga*. Mr. Hinds took the precaution to preserve specimens of his plant, some of which were entrusted to Mr. Berkeley for publication, who forwarded them to Dr. Montagne, who ascertained that, though belonging to the genus *Trichodesmium*, the plant was specifically distinct therefrom, and named it *T. Hindsii*.

I have been led, in having introduced the above account of the colouration of the waters of the sea, to depart from the strict limits of this work. The phenomenon is, however, so

analogous to what has been observed, though of course on a scale much smaller in portions of freshwater, that the one can scarcely be considered complete without a reference to the other, and both are of the highest interest. In the "Annales des Sciences Naturelles," 3d Series, t. ii., there is an able and elaborate memoir by Dr. Montagne, one of the first Cryptogamic Botanists of Europe, "Sur la Phénomène de la Coloration des Eaux de la Mer Rouge," which contains a great number of references to works in which mention has been made of the phenomenon of the colouration of the sea.

The sudden and periodical colouration of vast extents of the sea, has been, to uninformed minds, in early times, a subject of superstition and dread, these appearances having been regarded by the ignorant as Divine manifestations of anger or impending calamity; and that they should have been so regarded in days in which natural science was all but unknown, is scarcely surprising. The true explanation of the cause of these sudden and remarkable appearances, while it removes all feelings of superstition or dread, does not banish those of amazement and admiration which indeed supplant them.

The following appropriate observations in the memoir of Montagne, already referred to, occur: —

"The singular phenomenon of the colouration produced on the surface of the Red Sea, — a colouration in which we have seen the waters themselves do not participate, has been, each time that it occurs, a new subject of astonishment for the people who have witnessed it. It cannot be doubted, moreover, that the jugglers and charlatans, after having probably calculated in advance its periodical return, made use of it to govern the multitude by the menace of an approaching calamity, of which they failed not to present this sign as the undoubted precursor. It is also to a cause, if not altogether similar, at least very analogous, that is to be attributed, according to many naturalists, in the number of whom figures M. Ehrenberg, those rivers, waters, and lakes changed into blood in one of the plains of Egypt,—

an explanation which M. Morren considers somewhat hazardous, although not improbable. As to the phenomenon of the Red Sea, by the fact that its extent has impressed upon it a character of majesty calculated to affect strongly the imagination of the vulgar, it ought to produce still more sensation. Since now we know the origin of it, if we compare together the immensity of this phenomenon, and the infinite smallness of the being which produces it, one cannot divest oneself from a profound sentiment of admiration for the Omnipotence which effects such great ends with such feeble means."

Section i.

Filaments *not enclosed in gelatine of a definite form.*

32. SPIRILLUM *Ehr.*

Char. Filaments *spiral, æruginous green.*

1. Spirillum Jenneri *Hass.*

Plate LXXV. Fig. 5.

Char. Filaments *rather thick, each being usually composed of about eight or ten regular spiral coils.* Striæ *distant, perceptible.*

Hab. Tunbridge; *Mr. Jenner.*

This is the finest species of the genus. I have not seen a pure specimen, those sent me by Mr. Jenner being mixed up with different species of *Oscillatoriæ.*

2. Spirillum rupestre.

Plate LXXV. Fig. 6.

Char. Filaments *slender, regularly spiral.*

Oscillatoria spiralis Carm.

Hab. On rocks by the seaside where the birds are in the habit of resting, Appin: *Capt. Carmichael.*

"It spreads over the dry naked earth. Stratum several feet in extent, firm, coriaceous, of a glossy black colour, void of lubricity. Filaments about half a line in length, twisted like a corkscrew, radiating in all directions." — *Carm.*

When dried, the filaments lose their regularly spiral character.

3. Spirillum minutissimum *Hass.*

Plate LXXV. Fig. 8.

Char. Filaments *excessively small, describing usually about three turns.*

Hab. Ireland: *Mr. Moore.*

This exceedingly minute species I received from Mr. Moore. The spiral character of the filaments is retained in drying, which is not the case in the previous species. I was much surprised to notice, when examining a portion of a specimen which had been preserved for a considerable time, that the filaments were in lively movement, turning round and round repeatedly, and with exceeding rapidity.

4. Spirillum Thompsoni *Hass.*

Plate LXXV. Fig. 7.

Char. Threads *rather large, moniliform.* Globules *of equal size throughout their entire length.*

Anabaina ? spiralis Thompson, Annals of Nat. Hist. vol. v.

Hab. Ballydrain Lake, near Belfast: *Mr. Thompson.*

"The specimens obtained were invariably of similar breadth, and rarely presented more than four spiral turns, and when of this size were one fiftieth of an inch in length. The species at first, when mingling with the water, is of a dark green colour; when in calm weather it ascends to the surface in *separate* particles, it appears pale green; when it does so *en masse* (the earliest symptom of decay), it is of a pale blue; and in the last stage of decomposition, ferruginous. Having on the 27th September brought home in several phials spe-

cimens of what I had presumed to be this plant in all its stages (i. e. from its first to its last appearance as a colouring matter), I was much pleased to have the conjecture verified by microscopical examination. A portion taken from the surface when it appeared pale green was, under the microscope, of as dark a hue as in July, whilst the blue and ferruginous colours exhibited different stages of decomposition. When in the most perfect state in which the plant has occurred to me, the globules appear entirely filled with granules; but when very highly magnified are each found to be surrounded by a hyaline membrane. The blue and ferruginous tufts exhibited generally its empty globules and the escaped granules scattered all about; but the former were seen in every state from full to empty; some had granules only in the centre, others were half full, and some *separate* globules were entirely filled with the granular mass.

"When two of the spiral portions come in contact, they have an elastic power, by which they can, though slowly, disentangle themselves and separate from each other, a fact which I witnessed in various instances; but under such circumstance only did I ever perceive any motion in this *Alga*."

"In some respects the *Anab. spiralis* resembles the *Anab. impalpabilis* Bory, as described in the "Encyclopédie Méthodique;" but its dull green unlustrous hue on paper is quite opposed to that of the species just named, which is described—Préparée sur le papier, où on a facilité son développement, elle est de la teinte la plus brillante, tirant sur celle de l'oxide du cuivre, et luisant comme si on l'eut enduite d'eau de gomme." Besides, were this species of the *exact* spiral form of that under consideration, this character would not I conceive have been unnoticed in the description." — *Thompson.*

33. APHANIZOMENON *Morren.*

Char. "Filaments *simple, cylindrical, flexile, membranaceous, glossy, articulated, cohering together in flat lamellæ, lanceolated at the apex, straight, or here and there inflated, full of green matter, oscillating spontaneously, falling into pieces.*" — Morren.

Derivation. From *αφανιζομενον, a vanishing thing.*

"It is evident that this genus unites the true *Conjugatæ* to the *Zygnemata* by a union well marked in the latter, but being a simple soldering in the *Aphanizomena:* it relates the *Conjugatæ* with the *Laminariæ* of the sea by the form of the lamella, which results from the soldering of the threads: it establishes an analogy between the *Oscillatoriæ* and the *Confervæ*, by demonstrating that a movement of reptation, of swimming, or of oscillation, may appertain also to the organization as of the *Confervæ* as to that of the *Oscillatoriæ*, in which the characters of animality are supposed to be recognised: the inflated vesicles unite the *Aphanizomena* to the *Conferva vesicata* of Agardh, and the cells as well as the organization of the threads themselves maintain with the true *Confervæ* relations so clear, that it would be improper to place otherwise than amongst them this new genus." — *Morren.*

The true position of the genus is undoubtedly amongst the *Nostochineæ*, uniting them with the *Oscillatoriæ.* The analogies indicated by Bory are more imaginary than real.

1. Aphanizomenon incurvum *Morren.*

Plate LXXVI. Fig. 6.

Char. Lamella *plain, whitish green, incurved.* Threads *cohering.* Cells *from two to eight times as long as broad.*

Morren, in memoir read before the Royal Academy of Brussels, in Dec. 1839; Thompson, in Annals of Nat. Hist. vol. v. p. 82.; Harv. in Manual, p. 145.

Hab. In sheltered creeks, floating on the surface; Ballydrain Lake: *W. Thompson*, Esq. Grand Canal docks, near Dublin: *Professor G. J. Allman.* In the pond of the Dublin Zoological Gardens: *Miss Ball.*

"Towards the middle of the month of May, up to July, the waters of the lakes, the ponds, and the basins which surround the country houses in Flanders are noticed to present tufts of a whitish green, and of a size which varies from that of a

little pea to that of a melon. These tufts, which appear afar off cloud-like, are placed at a distance, the one from the other. One would consider them immovable; but seen nearer, they enjoy a veritable power of locomotion which allows of their being met at all heights in the waters. I have observed this year again a prodigious quantity of it at Gentbrugghe, near Gand." — *Bory.*

Mr. Thompson, who was the first to notice in Ireland this species, observes, in his remarks on it in the "Annals of Natural History," loc. cit. — "In Ballydrain Lake I have, both in 1838 and 1839, remarked its presence on very calm days, for it is only at such times visible during the month of July, August, and September, and then it appears in the most sheltered creeks only, floating in patches of various dimensions."

It has not yet been found in Great Britain.

34. ANABAINA *Bory.*

Char. "Filaments *frequently elegantly moniliform, curved, invested with mucous matter, and having a vermicular motion resembling that of worms.*"— Bory. Reproduction *consisting of sporules contained in enlarged cells, the form and size of which varies according to the species.*

Derivation. From *ava, up,* and *βαινω, to mount.*

"Their movement exhibits a relation with that by means of which the earthworms move from place to place; they are progressive, and the curves which they describe are of extreme slowness. It is by this ambulatory faculty principally that the aquatic species elevate themselves to the surface of the water, traversing the length of *Confervæ* and the remains of vegetables, mount to the surface of reeds and carices, penetrate the slime and the *Oscillatoriæ,* which they surmount in such a way that they merit the name derived from the Greek, by which we have proposed to designate them."

The remarks of Bory in the above quotation appear to me to be somewhat fanciful and overstrained. I much doubt whether this mounting upwards of the *Anabainæ* partakes in any de-

gree of a voluntary character, and whether the explanation given of the elevation to the surface of the waters of almost all the *Confervæ* is not sufficient to account for that of the *Anabainæ*. The explanation alluded to is the fact that during respiration a gas is eliminated, the globules of which becoming entangled in their filaments, renders them specifically lighter than the water, and so causes them to ascend.

1. ANABAINA FLOS-AQUÆ *Bory.*

Plate LXXV. Fig. 2.

Char. Filaments *large, beautifully moniliform, and variously curved.* Reproductive cells *numerous, elongated, and for the most part curved.*

Nostoc flos-aquæ Lyngb., Dan. p. 201. t. 68. *Anabaina flos-aquæ* Bory; Hudson, Flor. Ang. p. 604.; Light. Scot. p. 999.; Harvey in Manual, p. 186.

"This species attracted my attention when tinging with its delicate green hue the margin of the smallest (?) of the lochs Maben in Dumfries-shire, or that nearest to Jardine Hall (on the road from the village of Lochmaben), as I drove thither on the 15th of August, 1838. The day was calm and bright. My specimens tinge the paper with a verdigris colour, and are quite dull, or wanting in any lustrous appearance. This species is introduced here on account of its having been erased of late years from the British Flora. Hudson and Lightfoot included it without assigning to it any British station or locality." — *Thompson.* The reproductive cells, which, as noticed in the definition of the species, are curved to accommodate themselves to the various curvatures of the threads are mostly solitary, and I have never observed more than two contiguous to each other.

2. ANABAINA LICHENIFORMIS? *Bory.*

Plate LXXV. Fig. 4.

Char. Filaments *not moniliform, minute, but little curved.*

Reproductive cells *of various sizes, oval, and occurring in series.*

Bory, in Dict. Class. d. Hist. Nat. vol. i. p. 309.

Hab. Neighbourhood of Dublin: *Dr. Allman.* County Wicklow: *Mr. Moore.* Sussex: *Mr. Jenner.*

There is no species hitherto recorded with which this can possibly be confounded. The form of the reproductive cells, the various size of these and their occurrence in chains or series serving to mark it from all others.

3. Anabaina impalpebralis? *Bory.*

Plate LXXV. Fig. 3.

Char. Filaments *minute, not moniliform, but little curved.* Reproductive cells *large and quadriform.*

Bory, in Dict. Class. d. Hist. Nat. vol. i. p. 309.

Hab. Under a waterfall, co. Wicklow: *Mr. Moore.*

This is also a very distinct species; the reproductive cells are large, elongated, and in the form of a parallelogram, with the angles slightly rounded; they are also usually solitary, rarely in pairs. It dries without gloss.

4. Anabaina constricta *Hass.*

Plate LXXV. Fig. 9.

Char. Filaments *very slender, not moniliform.* Reproductive cells *much elongated, mostly solitary, small.*

Hab. On mosses, Cheshunt: *A. H. H.*

This species bears some resemblance to the preceding; the reproductive cells are, however, not nearly so large as in it, and are slightly constricted in the centre.

35. SPHÆROZYGA *Ag.*

Char. Stratum *gelatinous, in which undulate articulated unbranched* threads *with quadrangular joints, joined*

here and there to a spherical cell, *which is sometimes terminal.*

1. Sphærozyga Jacobi *Ag.*

Char. Threads *radiating, lonely, disposed in gelatine.*

Sphærozyga Jacobi Berk., in Eng. Bot. t. 2826. fig. 2.

Hab. Northamptonshire: *Rev. M. J. Berkeley.* Cromlyn Bog: *J. W. Gutch, Esq.*

This species would appear from the description to belong to *Anabaina* or *Aphanizomenon.* I have never seen it.

36. TRICHORMUS *Allman.*

Char. Frond *free, of undeterminate figure, consisting of simple, minute, moniliform, curved threads, with articulations of uniform size, immersed in a gelatinous matrix.*

Derivation. From θριξ, *hair,* and ὅρμος, *a necklace.*

"From *Anabaina* of Bory Saint Vincent the present *Alga,* as well as that of Mr. Thompson (*Anabaina? spiralis*), differs in the *uniform* size of the articulations, Bory's genus being characterised by larger globules occurring at distinct intervals in the series."—*Allman.**

Although strongly inclined to agree with my excellent and early friend Dr. Allman, as to the validity of the genus *Trichormus,* I am still not altogether satisfied respecting it, the suspicion resting on my mind that the *T. incurvus* Allm. might possibly be an *Anabaina* in a young stage of its developement, the reproductive enlarged cells not having as yet manifested themselves. This, however, is but a suspicion, against which may be urged the fact that in veritable *Anabainæ* the globules are invariably found interrupting the uniformity of the filaments.

* "On a New Genus of Algæ, belonging to the family of the Nostochineæ." By G. J. Allman, A.B., L.R.C.S.J., Secretary to the Dublin Microscopical Society. Annals of Nat. Hist. vol. xi. p. 161.

1. TRICHORMUS INCURVUS *Allm.*

Plate LXXV. Fig. 1.?

Char. "Plant *either diffused through the water or collected on the surface.* Filaments *of a pea-green colour, crowded together confusedly in a gelatinous matrix, variously curved, but never regularly spiral, assuming, when dried, a fine verdigris-green colour without lustre.*" — Allman.

Allman in Annals of Nat. Hist. vol. xi. p. 163.

Hab. In the Grand Canal dock, Dublin, October: *Dr. Allman.*

The only authentic specimen which I have seen of this species was so much injured that I was not able to make an examination of it in the least satisfactory. A specimen, however, sent me by Mr. Thompson, collected by that gentleman and found floating on the surface of Lough Neagh, at Shane's Castle, marked *Anabaina flos-aquæ*, accords so well with the description and figure given by Dr. Allman of *T. incurvus*, that scarcely a doubt remains as to the propriety of regarding Mr. Thompson's plant as that species, see Pl. LXXV. fig. 1. From the true *A. flos-aquæ* Mr. Thompson's specimens differ in the less considerable dimensions of the filaments, and in the absence of the enlarged cells.

Section ii.

Filaments *invested in a mucous matrix of a definite form.*

37. MONORMIA *Berkeley.*

Char. "Frond *branched, composed of a single moniliform thread, following the ramifications, immersed in gelatine.*" — Berk.

Derivation. From *μονος, one,* and *ὁρμος, a necklace.*

This genus scarcely differs from *Nostoc*, between which and *Anabaina* it forms a clear link.

1. MONORMIA INTRICATA *Berk.*

Plate LXXV. Fig. 11.

Char. Filaments *scarcely moniliform.* Reproductive cells *infrequent, globular, in series.*

Monormia intricata Berk., Gl. of Alg. p. 46. t. 18.; Harv. in Manual, p. 185. *Nostoc intricatum* Meneghini, Monographia Nostochinearum Italicarum, p. 122. with fig.

Hab. In ditches of the marsh to the south of Frindsbury Canal, near Gravesend, in great abundance in June, 1832: *Rev. M. J. Berkeley.*

" Forming small roundish gelatinous masses, floating amongst different species of *Lemna* in fresh water, but probably within the influence of the tide, and also amongst *Enteromorpha intestinalis,* and even within the frond in brackish water. The plant is at first of an olive yellow, gradually assuming a greener tint, and when dried of a deep verdigris. Very gelatinous, delicately branched; the branches very flaccid. Under a high magnifier the whole plant is evidently composed of gelatine, in the centre of which runs a single moniliform filament, following the ramifications, and in its progress curling to and fro repeatedly across the thread, the joints being nearly globular. The specimens from the interior of *Enteromorpha* are paler, and have often longer joints amongst the globular ones."—*Berk.*

In the authentic specimen which I have examined of this beautiful production, the articulations of the threads themselves could scarcely be called moniliform, although the large reproductive cells were distinctly so.

38. NOSTOC *Vauch.*

Char. Frond *definite, gelatinous or coriaceous, globose or lobed, filled with curled beaded simple filaments.* Reproduction *consisting of enlarged spherical cells placed irregularly in*

the course of the filaments, from which finally they become separated.

"This name is unexplained: it was first used by Paracelsus, and adopted by Vaucher for the present group, which before that time was included in *Tremella.*"—Harv.

1. NOSTOC VARIEGATUM *Moore.*

Plate LXXIV. Fig. 3.

Char. Frond *terrestrial, expanded, gelatinous, livid, variable in shape.* Filaments *rather distant.* Cells *oval, and variable in size.*

Harv. in Manual, p. 183.

Hab. Ireland: *Mr. Moore.*

"This singular plant I first collected in 1836, growing on the face of a moist bank over which water trickled. When recent it formed a soft gelatinous mass, of a livid colour, bearing the closest resemblance, both in substance and colour, to those gelatinous *Medusæ* which are cast ashore along the coast, and called by the country people 'fallen stars.' I again collected it on the same spot in 1838, when I sent Dr. Greville specimens, who thinks it different from any thing he knows, and coming nearest to *Nostoc commune.*"—*Moore's MS.*

If I had acted on my own convictions in reference to this species, I should have removed it to the genus *Anabaina*, to which it seems more properly to belong than to *Nostoc.* In the genus *Nostoc* there is an exact similarity in all the filaments; in the species under consideration, a considerable want of uniformity is observed, some being composed of cells larger than those of others, as may be seen by the figure, in which particular it resembles *Anabaina*, as it does also in the diffused or unlimited mucous matrix, in which the threads are imbedded, and in the oval form of the enlarged or reproductive cells.

2. Nostoc commune *Vauch.*

Plate LXXIV. Fig. 2.

Char. Frond *terrestrial, expanded, membranaceous, plaited, waved, or curled; olive green, shining, and irregular in form.* Filaments *thick, beautifully moniliform.* Reproductive cells *large, either attached to the filaments, or lying scattered throughout the frond.*

Nostoc commune Vauch., Hist. des Conf. p. 223. pl. xvi. f. 1. *Tremella Nostoc*, Eng. Bot. t. 461. *Tremella terrestris* Dill., Musc. p. 52. t. 10. f. 14.; Harvey in Manual, p. 183.; Meneghini, Monographia Nostochinearum Italicarum.

Hab. "Gravelly soils, garden walks, rocks, pastures, &c.; very common in autumn and winter."

The filaments are large, exactly moniliform, flexuous, and copious, with here and there an enlarged reproductive cell of an exactly spherical form. These enlarged cells occur either in the course of the filaments, are terminal, or lie detached in the mucous matrix of the frond. Some writers have laid great stress, in their descriptions, upon the fact of these globules being so frequently terminal. This position of them has nothing to do with the developement of the species, but arises from the thread of which they formed a link having separated from one side of them — a step preparatory to their being altogether cast off by the filaments.

"In prima tantum hujusce speciei ætate deprehendenda est interior substantia aquosa-gelatinosa, qua cito elapsa frons excavata potius quam vesicæformis efficitur, stratum enim periphericum, ratione habita cavitate interiori, multo crassius est in cæteris omnibus speciebus." — *Menegh.*

The only species with which there is any danger of confounding *Nostoc commune* are, *N. cæruleum* and *N. foliaceum*. The filaments of *N. commune* correspond in size and appearance very closely with those of *N. cæruleum*, but the external characters are altogether distinct; the contrary is the case with *N. foliaceum*, the external characters resembling those

of *N. commune*, but the filaments are different, being much smaller in size, although, like those of *N. commune*, distinctly moniliform.

3. NOSTOC FOLIACEUM *Ag.*

Plate LXXVI. Fig. 2.

Char. Frond *membranaceous, erect, plaited, olive green.* Filaments *slender, copious, moniliform.* Enlarged globuli *numerous.*

Nostoc foliaceum Ag., Syst. p. 19.; Harv. in Hook. Br. Flora, ii. p. 399.; Harv. in Manual, p. 184.; Meneghini, Monographia Nostochinearum Italicarum, vol. v. p. 18. serie ii. delle Memorie della R. Academie delle Scienze di Turino.

Hab. On clayey ground kept constantly damp by the oozing of water, Appin: *Capt. Carmichael.* Ireland: *Mr. Moore.*

"This species is easily distinguished both by its appearance and station from *Nostoc commune*, to which it seems similar, as respects certain external characters. It never swells up into the form of a vesicle; the structure, altogether uniform, extends as a membrane, and rises up by moisture into plicated lobes: it grows on stones, and is evolved, the winter scarcely being ended, when *Nostoc commune* has not yet appeared."—*Menegh.* The difference in the size of the filaments of *Nostoc commune* and *N. foliaceum* is perhaps the only character whereby the two species can at all times be discriminated, the threads being much smaller in the latter species.

4. NOSTOC SPHÆRICUM *Vauch.*

Plate LXXVI. Fig. 5.

Char. Frond *small, globose, densely aggregated, solid, smooth, olive green, watery within.* Filaments *small, moniliform.*

Nostoc sphæricum Vauch., Conf. p. 223. pl. xv. f. 2.

Ulva pisiformis Hudson. *Conf. pisum*, Flor. Dan.; Harv. in Hook. Brit. Flor. p. 400.; Harv. in Manual, p. 185.; Meneghini, Monographia Nostochinearum, p. 110.

Hab. In rivulets and fountains, attached to stones, &c. Appin: *Captain Carmichael.* Pools near Barmouth and Llyn Coron, near Anglesea: *Mr. Ralfs.* Co. Wicklow: *Mr. Moore.*

"Fronds from half a line to two lines in diameter, globular, firm, smooth, solid, heaped on each other like a parcel of small shells. Internal filaments rather thinly scattered through the mass." — *Carm.*

"This species dried and again moistened sometimes emit a most grateful violet odour, as though it were a species of *Chroolepis*, and such as no other *Alga* of the family of *Nostochineæ* presents." — *Menegh.*

The filaments are moniliform, and exactly correspond with those of *Nostoc foliaceum* in size, the young state of which species, as it agrees with it also in habit, it may eventually prove to be.

5. NOSTOC VESICARIUM *D. C.*

Char. "Frond *globose, plicated, greenish yellow, the internal viscid mucus escaped, vesicæform, cartilaginous.* Filaments *curved, slender, with* cells *twice as large, thickly interspersed and terminal.*" — Menegh.

D. C. Flor. Fr. vol. iii.; Harv. in Hook. Br. Flor. p. 399.; Harv. in Manual, p. 184.; Ag. Syst. p. 19.; Meneghini, Monographia Nostochinearum, p. 108.

Hab. Road-side, near Perth: *G. A. W. Arnott*, Esq.

"The diameter of the frond varies from a millimetre to an inch. The colour in the smaller fronds obscurely green, verges in the larger to a yellowish brown. *Substance* firm, cartilaginous, including a fluid viscous juice: afterwards, the gelatinous substance having escaped, empty, vesicæform, membranaceous;

threads moniliform, in the interior substance very lax, in the external stratum much more curved than in *Nostoc commune*, smaller in diameter, they scarcely attain three millimetres; but the larger spherical globules, twice as thick, abound, and sometimes form tracts more or less long, no smaller globule occurring between. In adult specimens the threads are varicose wherever they occur." — *Meneghini.*

6. Nostoc verrucosum *Vauch.*

Plate LXXV. Fig. 1.

Char. Frond *attached, large, subglobose, in the beginning solid, externally subcoriaceous, within gelatinous, at length hollow, vesicæform, verrucose, brownish green; when dried æruginous.* Filaments *dense, slender, almost cylindrical.*

Nostoc verrucosum Vauch., Hist. des Conf. *Tremella fluviatilis* Dillw., Musc.; Harv. in Hook. Br. Fl. p. 400.; also in Manual, p. 185.; Meneghini, in loc. cit.; Thuret, in Annales des Sciences Naturelles.

Hab. On stones in Alpine streams; Aberdeen: *Dr. Dickie.*

This species may be distinguished from most others of the genus by the nature of the filaments, which are almost cylindrical. The species with which it is most likely to be confounded is *Nostoc pruiniforme*, the filaments of which resemble it closely, but are considerably larger; in other respects the two species are widely different, being estranged in form, habit and consistence.

7. Nostoc pruiniforme *Ag.*

Plate LXXVI. Figs. 3, 4.

Char. Frond *unattached, solitary, globose, smooth, olivaceous, gelatino-coriaceous, within watery.* Filaments *somewhat thick, almost cylindrical.*

Ag. Disp. p. 45.; Berk. Gl. p. 48. t. 19. f. 2.; Lyngb.

Hydroph. p. 200. t. 68 a.; Harv. in Hook. Br. Fl. p. 399.; also in Manual, p. 184.; Meneghini, loc. cit. p. 114.

Hab. In freshwater pools near the coast; rivulet near Torquay: *Sir W. J. Hooker.* Appin: *Captain Carmichael.*

"Fronds unattached, scattered at random in the clefts of the rocks, globular, smooth, olive-green, diaphanous, from ¼ to 1½ inches in diameter, the larger ones generally compressed, hollowed, and sometimes ruptured." — *Carmichael.*

The filaments, as remarked in the description of the preceding species, resemble those of *Nostoc verrucosum* in all, save size, being larger than in that species. The reproductive cells are rarely produced.

8. Nostoc muscorum *Ag.*

Plate LXXIV. Fig. 4.

Char. Frond *tuberculate, subcoriaceous, variable in shape.* Filaments *much curved, moniliform, exceedingly slender.*

Ag. Disp. p. 44.; Ag. Syn. p. 132.; Syst. p. 19.; Harv. in Hook. Br. Fl. p. 399. *N. muscorum* Harv., in Manual, p. 183. *N. microscopicum* Carm., MS.; Harv. in Manual, p. 184.; Meneghini, Nostochinearum Italicarum, p. 119.

Hab. *N. muscorum,* on calcareous rocks, and the mosses which cover them, Appin: *Captain Carmichael.* — *N. microscopicum,* on exposed calcareous rocks among mosses, Appin: *Captain Carmichael.* Near Youghal: *Miss Ball.* Wilderness, near Clonmel: *W. H. Harvey.* Clayey banks, co. Antrim: *Mr. Moore.*

I have examined several of Carmichael's specimens of this *Nostoc,* and compared them with others of *Nostoc microscopicum* Carm., and I entertain no doubt of the specific identity of both. All the specimens which I have received of the former have consisted not of single fronds, but of an aggregation of numerous smaller fronds of various sizes and

forms, most of them being spherical but many of them angular. The filaments are minute, much curved, and the cells are spherical or slightly oval. It is one of the most distinct and beautiful species of the genus. In the smaller specimens, there is but a single thread, which curves in an elegant manner throughout the frond.

9. NOSTOC CÆRULEUM *Lyngb.*

Plate LXXVI. Fig. 11. Plate LXXV. Fig. 10.
Plate LXXIV. Fig. 1.

Char. Frond *solitary, small, globose, solid, fluid within, at length vesicular, mostly pale blue, sub-pellucid.* Filaments *large, elegantly moniliform, much curved.*

Nostoc cæruleum Lyngb., Hydroph. p. 201. No. 6. 768. β; Grev. Crypt. Fl. t. 131.; Hook. Brit. Flor. p. 400.; Harv. in Manual, p. 185.; Meneghini, Monographia Nostochinearum Italicarum, p. 111.

Hab. In flowing water or in very moist places attached to mosses, near Calender: *Dr. Greville.* Co. Antrim; near Wicklow: *Mr. D. Moore.* Pass of Lerry: *Dr. Greville.*

This species in its dried state might be readily passed over as *Nostoc commune* in the first period of its growth, the filaments of *N. cæruleum* according exactly with those of that species. Notwithstanding the difference in its colour, and perhaps in its habit also, I am not perfectly assured that it is really distinct. The larger size of the filaments will serve to distinguish it from *Nostoc sphæricum,* which in form it resembles, as well as the difference in its colour, and its greater mucosity, which causes it to adhere closely to paper.

10. NOSTOC MACROSPORUM? *Menegh.*

Plate LXXIII. Figs. 1, 2.

Char. Frond *minute, solid, spherical, æruginous green.*

Filaments *curved, thick, almost cylindrical, with here and there an enlarged spherical cellule.*

N. crassisporum Menegh., Consp. Alg. Europ. p. 7.; et *N. macrosporum*, Monographia Nostochinearum Italicarum, p. 116. pl. xiv. fig. 2.

Hab. Ireland: *Mr. Moore.*

Meneghini describes the frond of his *N. macrosporum* as being polymorphous; in my specimens it was regularly spherical. Meneghini's description, however, in other respects accords so well with my examples that there scarcely a doubt can exist as to their identity with the *N. macrosporum.*

" But different objects stimulate different minds to inquiry. Perhaps the contemplation of the vegetable kingdom may be suited to the varied conditions of more persons than the investigation of the animal structure; for plants, abundantly bordering our paths, are more readily procured for the purposes of analytical examination, attract more continual attention in our moments of leisure by many trivial allurements, and give little or no shock to the most irritable sympathies during dissection. The vegetable kingdom, as a manifest part of a universally concatenated system, presents unquestionable traces of the great Intelligence which has planned and constructed the whole. These traces appear so singularly diversified through every part of the great sphere of human observation, that the conclusion is irresistible, that such diversity has been especially intended as a final cause to awaken admiration in beings of duly adapted intelligence, to stimulate feelings made to be in harmony with such display of beauty and of glory; with a purpose to obviate all doubt, to evoke continual rapture, and to elevate the soul of man through transitions of fear and wonder and awe to adoration and to divine love, which is said to be the perfection of all wisdom."—*J. S. Duncan's Botanical Theology.*

ALGÆ GLOBULIFERÆ.

Fam. XVI. ULVACEÆ.

Char. Frond *gelatinous, saccate, tubulose, or membranaceous.* Cells *either spherical and scattered singly throughout the mucous frond irregularly, in pairs, in fours, or multiples of that number; or polygonal, and crowded together.*

The species of the family *Ulvaceæ* appear, so far as the freshwater examples are concerned, to require a separation into two sections: the first including the genera *Ulva*, at least the single freshwater species of that genus *Ulva bullosa* (of the marine species, I have no exact knowledge), *Tetraspora*, *Hydrurus*, and *Merismopedia*; the second, the genus *Enteromorpha*. In the first, the cells are small, and spherical, being imbedded at considerable intervals from each other in the mucous frond; in the second, the cells are large, polygonal, and attached firmly to each other, the mucous nidus having disappeared.

The reproduction of this family does not appear to have been satisfactorily determined. In Agardh's memoir on the propagation of the *Algæ*, referred to so often, the following remarks occur: —

"My father advanced the opinion that the cellules disposed often in fours were the seeds, which was contradicted by Lyngbye. Greville in the work cited above * observes, that from three to four granules are disposed in the cellules of the frond, but he pronounces not upon the function which ought to be attributed to these granules. In this uncertainty, some observations on the movement of the globules of *Tetraspora lubrica*, should easily decide the question; but no person

* Algæ Britannicæ.

having as yet observed the act itself of their disjunction from the membrane, it has not been ascertained whether it was the cells themselves or that which they contain which escaped from it. That which is certain is, that the sporules of this plant are not more naked (an opinion advanced by M. Gaillon) than those of any other *Ulvaceæ*.

"The *Ulvaceæ* properly so called are composed of cells sometimes arranged in a single layer, which constitutes an elongated tube entirely empty, sometimes disposed in two layers, compressed the one against the other, and forming a flat membrane more or less extensive. Their sporules are lodged in these cells, and issuing by a pore situated on the surface, they offer the same phenomenon of locomotion which we have seen to belong to the preceding families.

"Their movement is more slow and in the cellules straighter than amongst the *Conferveæ*. Their beak is not so pointed, and is not near so well separated from the body; but nevertheless it is always the thinnest end of the oviform bodies which is foremost during the movement. The sporules are five or six in number in each cellule; in some of them there were two or three which were much smaller than the others, a difference which is also observed in the *Conferveæ*, but in a manner less apparent.

"Finally, it is only in the *Ulva clathrata* that I have observed the complete developement of these sporules. The germination (if one may so name a phenomenon analogous to that act in more perfect plants) consists in this species of a longitudinal expansion, during which the green matter insensibly transforms itself into transverse bands. In this state one might easily take the young plant for a species of *Conferva*, but soon the bands being divided longitudinally, and so become disposed in two series, one cannot longer mistake it."

Section i.

Granules *simply imbedded in the frond.*

39. ULVA *Linn.*

Char. Frond *gelatinous, saccate or membranaceous.* Cells

scattered through the frond either singly, in pairs, or in fours.

Name supposed to be from *ul*, water, in Celtic.

1. Ulva bullosa *Roth.*

Plate LXXVIII. Fig. 13.

Char. Frond *very delicate, somewhat gelatinous, at first saccate, afterwards becoming expanded into a broad waved or torn floating membrane.*

Eng. Bot. t. 2320.; Hook. Brit. Flor. vol. ii. p. 312.; Harv. in Manual, p. 171.

Hab. In stagnant freshwater ponds and ditches.

Fronds clustered, at first fixed, afterwards floating, very thin and gelatinous, of a pale green colour, becoming yellowish. Cells in the fully developed plant single, and equally diffused throughout the lamina. If this disposition of the cells be not constant, and if in the young condition of the frond they are ever arranged in fours, as I believe to be the case, then I think that this species can scarcely be regarded as distinct from *Tetraspora lubrica*. The size of the cells is the same in both.

2. Ulva crispa *Light.*

Plate LXXVIII. Fig. 12.

Char. Fronds *terrestrial, saccate, firm, densely tufted, plaited and wrinkled, of a roundish form.* Cells *arranged in fours, crowded.*

Ulva crispa Lightfoot. Grev. Alg. Brit. p. 175.; Hook. Brit. Flor. vol. ii. p. 312.; Harvey, in Manual, p. 171. *Ulva furfuracea* Horncastle. Grev. Crypt. t. 265.; Hook. Brit. Flor. p. 312.; Harvey, in Manual, p. 171.; E. B. t. 2754.

Hab. On damp ground, rocks, thatched roofs, &c.; very common, winter and spring; rocks near the sea: Appin: *Captain Carmichael.* On the walls of King's College, Cambridge: *Rev. M. J. Berkeley.* Several places near

Limerick: *W. H. Harvey.* Near Ballycastle: *Mr. D. Moore.* Roger's Tower on Castle an Dinas, near Gulvall; and Bosigran Castle, near Morvah; in both places on granite: *Mr. Borrer.* Dublin Bay: *Mr. Moore.* On damp shaded walls, on the ground; frequent, near Tunbridge Wells: *Mr. Jenner.* Walls of Chesterton church, near Cambridge: *Rev. Prof. Henslow.*

Having carefully examined numerous specimens which have been sent me under the names of *Ulva crispa* and *Ulva furfuracea*, and not being able to detect the slightest difference in the microscopic characters of these, I do not hesitate to unite the two supposed species.

The specific denominations of *crispa* and *furfuracea* are both well expressive of the appearance of this species: the cells are densely crowded together in the frond, so as indeed to leave very narrow interspaces between the groups of cells, which are usually composed each of about sixteen cells, disposed in fours, and which from the compression one against the other are rendered somewhat angular. The different groups of cells are not disposed usually in linear series.

3. Ulva calophylla *Spreng.*

Plate LXXVII. Fig. 1.

Char. Frond *densely tufted, plane, linear, ligulate, attenuated at base, often stipitate, longitudinally striate, each stria marked with a series of bi-quaternate granules.*

Hook. Brit. Flor. vol. ii. p. 312. *Bangia colophylla* Carm., in Grev. Crypt. Fl., t. 220.

Hab. On damp stones, rocks, &c.; Lismore Island, Appin: *Captain Carmichael.* Near Limerick: *W. H. Harvey.* Dublin: *Mr. Moore* and *Dr. G. J. Allman.* North of Ireland: *Mr. D. Moore.* Oswestry: *Rev. J. Salwey.*

"This forms a bright green thin stratum. Frond minute, three or four lines long, linear, strap-shaped, obtuse, tapering at base, or suddenly contracted into a cylindrical stipes, much

waved and curled, very variable in breadth. Granules quaternate, closely covering the frond, set in longitudinal lines, of which two or more (sometimes half a dozen) form the breadth of the frond; interstices colourless." — *Harv.*

Kützing makes a new genus for this species under the name of *Prasiola.*

4. Ulva binalis *Hass.*

Char. Cells *large, in twos.*

I have not studied this species with sufficient attention to pronounce decidedly whether it is distinct or not; the arrangement of the granules by twos would seem, however, to be remarkable, and to render it very probable that it really is so. This species would appear to be referred to in the following remarks of Vaucher's "Hist. des Conf." p. 238. "It is not impossible but that other species of freshwater *Ulvæ* exist independently of those which I have described. I have myself met with some others which have appeared to me to be different from the two first; one in particular, the grains of which were disposed two by two, and not four by four; but I pass them by under silence, because I am not assured whether they are species or only varieties."

40. MERISMOPEDIA.

Char. Frond *increasing by spontaneous division, laminar, quadrangular.*

Derivation. From *μεριςμος, a division,* and *πεδιον, a fetter* or *chain.*

1. Merismopedia punctata *Meyen.*

Plate LXXXIV. Fig. 6.

Char. "*Green, corpuscles imbedded in a crystalline membrane, and nearly the* $\frac{1}{120}$ *of a millimetre in size, polypary, quadrangular, flattened, sometimes twice as broad as long, equalling from the* $\frac{1}{12}$ *to* $\frac{1}{6}$ *of a millimetre, and containing sixteen simple corpuscles, either binary or quaternary.*" — Ehr.

Merismopedia punctata Jenner, in Fl. of Tunbridge Wells. *Gonium tranquillum* Ehr., Die Infus. p. 57. t. iii. f. 3.

Hab. Ashdown Forest, Cold Bath Spring, &c.: *Mr. Jenner.*

I am not at all acquainted with this pretty production; it doubtless, however, belongs to the family of *Ulvaceæ*, and my *Ulva binalis* may possibly be identical with it.

41. TETRASPORA *Link.*

Char. Frond *either tubular, inflated, or flat, gelatinous.* Cells *mostly arranged in fours.*

Derivation. From τετρα, *four*, and σπορα, *a seed*; in allusion to the arrangement of the cells.

This genus seems to me to be wholly unnecessary: it ought either to merge into *Ulva*, or else several species now associated with that genus should be removed from it and placed in *Tetraspora*. All the characters of the genus *Tetraspora* may be found in one or other species of *Ulva*, and especially that of the quaternate arrangement of the granules, or perhaps more strictly speaking, the cells, from which the generic denomination is derived.

1. TETRASPORA LUBRICA *Ag.*

Plate LXXVIII. Fig. 10.

Char. "Frond *quite simple, tubular, subgelatinous, waved and serrated.*"

Harv. in Hook. Brit. Flor. vol. ii. p. 313.; Harvey, in Manual, p. 176.

Hab. Hellesdon, Norfolk: *Sir W. J. Hooker.* Appin: *Captain Carmichael.* Castlemartyr, Cork: *Miss Ball.* Malahide: *Mr. Moore.* Aberdeen: *Dr. Dickie.* In an old quarry above Cromlyn Bog, Swansea: *J. W. Gutch.* Tunbridge Wells: *Mr. Jenner.*

The freshwater *Ulvaceæ* have not as yet been studied with

the attention which they require. I do not feel at all certain that either this species, or *Tet. gelatinosa* are really distinct from *Ulva bullosa:* at all events, it is certain that in *Ulva bullosa* in its young state the frond is saccate or tubular, and the granules arranged in fours: neither can any difference be detected in the size of the cells in these supposed species: all which circumstances lead to the suspicion that they are but states of the same production. If the observation of Vaucher be correct that the granules or cells undergo an increase of size at the period of the complete developement of the frond, and just before it passes to decay, then it would seem that no certain character can be derived from their size, unless the condition of the species as to age be likewise ascertained.

The frond of *T. lubrica* is stated to be larger than in the following species, less gelatinous, with a more distinct membrane and of a deeper colour. The tube finally ruptures, and becomes membranaceous, with an irregular outline.

2. TETRASPORA GELATINOSA *Desv.*

Char. Frond *ovate, inflated, and very gelatinous.*

Hook. Br. Fl. p. 313.; Harv. in Manual, p. 176.

Hab. In freshwater streams attached to aquatic plants; Newcross, Killarney: *W. H. Harvey.* Botanic Garden, Belfast: *Dr. Drummond.* Malahide: *Mr. Moore.*

"Frond exceedingly lubricous and gelatinous, but firm, delicately waved, and plaited, of an oval outline. Sporules bright green, or arranged in fours or scattered."—*Harv.*

3. TETRASPORA FLAVA *Hass.*

Plate LXXVIII. Fig. 11.

Char. Frond *when dried yellowish.* Cells *very minute.*

Hab. Rocky rivulet, co. Antrim: *Mr. Moore.*

This species at all events would appear to be distinct, the cells being two or three times smaller than those of the two preceding *Tetrasporæ.*

42. HYDRURUS *Ag.*

Char. Frond *gelatinous, cylindrical, branched, solid, filled with scattered, oviform, bright green granules.*

Derivation. From *ὑδωρ, water,* and *ουρα, a tail.*

1. Hydrurus Ducluzelii *Ag.*

Plate LXXVII. Fig. 3.

Char. Frond *very gelatinous, branched, plumose.*

Ag. Consp. Crit. Diat. p. 27. *Batrachospermum Myosurus* Ducluz. *Palmella Myosurus* Lyngb., Dan. t. 68.; Harv. in Manual, p. 180.

Hab. In alpine rivulets, on stones, &c. In the river Walkam, near Tavistock: *Mr. Ralfs.* Meary, Devon: *Rev. W. S. Hore.*

"Root scutate, blackish, rather hard. Fronds clustered, solid, very gelatinous, 2—6 inches long or more, 2—4 lines in diameter, cylindrical, freely waving in the water, attenuated towards the apex, branched; branches scattered, alternate, elongate, slender, beset with other more slender, short ramuli. Gelatinous mass pellucid, viscid, colourless under the microscope, without apparent margin, unless as the granules imbedded within its substance indicate such; these are globose, green, formed in the stem and primary branches, most densely set in the ramuli, especially towards the margin. Colour of the recent frond brownish-olive, or dark brown, in drying, green; of the granules both recent and dry, green.

"The odour, in a recent state, is very offensive, and as Lyngbye remarks, only to be submitted to by an algologist. In a dry state it shrinks much, and most closely adheres to paper. Having only seen this very interesting plant in a dry state, I have thought it better to copy the above description from Lyngbye. Our specimens, so far as they can be examined, well agree with his figure. The affinities of the genus are doubtful. By Agardh it is now placed near *Schizonema,*

to which its offensive smell certainly allies it. But the form and appearance of the granules are so totally unlike the frustules of any diatomaceous plant, that, for the present at least, I retain it near *Palmella*, to which it seems to me about as much allied as *Chætophora endiviæfolia* to the shapeless species of that genus. If a true diatomaceous plant, it ought, as Agardh suggests, to form the type of a new *series*, of which, perhaps, our *Cymbella lætevirens* might represent the lowest form." — *Harv.*

There is not the least question but that the *Hydrurus Ducluzelii* is not a diatomaceous plant, and it is equally clear that it is an undoubted member of the family of the *Ulvaceæ*, in some measure connecting *Ulva* with *Enteromorpha*. The granules are oviform, precisely resemble zoospores, with which in function it is difficult to conceive that they are not identical, the thin being transparent.

Section ii.

Frond *reticulate*.

43. ENTEROMORPHA *Link.*

Char. Frond *tubular, hollow, membranaceous, and of a reticulate structure.* Fructification *consisting of three or four granules aggregated in the reticulations.*

Derivation. From *εντερον, the entrail,* and *μορφη, a form* or *appearance.*

1. ENTEROMORPHA INTESTINALIS *Link.*

Plate LXXVII. Fig. 2.

Char. Fronds *elongated, simple, inflated, often floating.*

Grev. Alg. Brit. p. 179.; Wyatt, Alg. Dar. No. 80. E. B. 2756.; Harv. in Hook. Brit. Flor. p. 313.; et in Manual, p. 174. *E. lacustris* Hassall, in Trans. of Linnæan Society.

Hab. In ditches. Common, summer and autumn.

"Fronds often two feet or more long, and from a line to two or three inches in diameter, tapering at base, at first fixed by a minute root, afterwards detached and freely floating, inflated, variously waved or curled, of a full green colour, fading to yellowish, and finally white." — *Harv.*

"In the earliest stage of their developement, the tapering filaments consist of a single series of cells placed end to end. Each of these cells afterwards becomes bisected by a longitudinal line, and other lines subsequently appear, so that the original cells are ultimately divided into several, each of which, in its turn, enlarges, and is in like manner divided. From the continued growth and unlimited division of the cells the filaments increase to an indefinite size, soon lose their original confervoid character, present a reticulated appearance, and, instead of being attenuated, become cylindrical and hollow.

"In each cell or articulation of the filaments, and when these are not thicker than a horse hair, a dark central nucleus is gradually developed, which, there can be no doubt, undergoes repeated division in the same manner as the reproductive globules of the *Ulvæ*. These nuclei often germinate while still enclosed within the cells in which they were developed, and while the parent filament retains all its freshness and vigour, and give rise to the pointed and tapering filaments first described; which, in this state, after the rupture of the parent cells, and while their bases are fixed within them, one filament in each, bear a strong resemblance to a parasitic *Conferva.*

"This developement, division and growth of cells and reproductive bodies, appears to be going on continually and successively, so that most specimens of the plant present examples of each different stage of its formation.

"The *Enteromorpha intestinalis* would appear to have a twofold relation to the *Confervæ* in its young articulated filaments, and to the *Ulvæ* in its reproduction from globules which undergo repeated division. The tautology of the specific name is objectionable, and that of *lacustris* might be substituted for it." — *Hass.*

44. BOTRYDUM *Wall.*

Char. "Plant *a spherical vesicular receptacle, filled with a watery fluid, dehiscent at the apex, terminating below in radiating tufts of fibres.*" — Grev.

Derivation. From *βοτρυς, a bunch of grapes,* which the clustered fronds somewhat resemble.

1. BOTRYDUM GRANULATUM *Grev.*

Plate LXXVII. Fig. 5.

Grev. Alg. Brit. p. 196. t. 19.; Hooker's Brit. Flor. 321. *Tremella granulata,* E. B. t. 234. *Conf. multicapsularis* Dillw. t. 71.? *Gongoseira clavata?* Kützing, Phy. Gen. p. 281.

Hab. On damp clayey ground, dried up ponds, &c. Common.

"Fronds minute, densely clustered on the surface of the ground, spreading in patches. Vesicle containing a watery fluid, in which a few granules are sometimes found. In dry weather the upper part of the vesicle collapses, when they become cup-shaped." — *Harv.*

Kützing I believe has not included in his "Phycologia Generalis" the genus *Botrydium:* he has constituted, however, a new genus for the *Conf. multicapsularis* of Dillw., under the name of *Gongoseira.* This genus he places amongst the *Protonemeæ,* which is probably the position which this curious production ought to occupy.

"Thus natural history blends with primitive tradition and record, affording to our faith a basis of previous probability, with evidence on every side, in our paths, our fields, our gardens, our woods; in cultivation and in the desert; in every fibre, root, stem, leaf, flower, or fruit, demonstrating the omnipotent all-sustaining omnipresent God." — *J. S. Duncan's Botanical Theology.*

Fam. XVII. PALMELLEÆ.

Char. Frond *consisting of a gelatinous colourless fluid, in which are immersed numerous* globules, *containing the colouring matter.*

45. PALMELLA *Lyngb.*

Char. "Frond *mucous, indefinite, enclosing hyaline* globules, *in which the colouring substance, continuous, and never granular, is situated.* Granules *first evolved in the mucous substratum of the frond, at length constituting new globules.*" — Meneghini.

Derivation. From *παλμος, vibration;* in allusion to the gelatinous nature of the frond.

"This genus differs from all the other genera of *Nostochineæ*, especially in its frond, which, from the beginning, is indefinite. In other species the frond preserves its defined form during the entire course of its existence, or at least in the beginning describes a certain form with peculiar limits. But in this, the frond never can possess a definite form, on account of the nature of its generation and evolution; for the globules living in the mucous substratum of the frond, otherwise very similar to those of other *Nostochineæ*, differ as much as possible from all others, in the fact of the colouring matter in them never becoming granular, and that, because the granules from which new globules proceed are neither evolved nor undergo evolution in the interior of the maternal globules; for these are either altogether resolved into mucus, or pour out the mucous substance which they contain, which substance not being covered with an involucre, is indefinitely diffused, and is circumscribed only by external circumstances. But in this mucosity minute punctated points or granules appear, which little by little are evolved, and at length attain to the dimensions of the parent globules. The

form, therefore, of the frond is necessarily indefinite. By reason of the absence of the vesicles nourished in the interior of the larger globules, the material included in the globules is altogether continuous, fluid, and never granular. At length, when effused, the presence of dots or minute granules dispersed through the mucous substratum afford distinct characters whereby the genus may be easily distinguished by microscopic examination.

In the genus *Palmella*, as limited by himself, Meneghini describes two species, *Palmella cruenta* and *P. montana*. The first of these Meneghini takes for the type of his genus *Palmella*, and to this only do his observations in any measure apply. The other species seems to me to be of a nature altogether different, indeed scarcely congeneric. In *P. cruenta* the grains or cells are loosely scattered through the mucous matrix, and their contents are usually, as Meneghini describes them, uniform and homogeneous. In *P. montana*, *P. Ralfsii*, *P. virescens*, and *P. grumosa*, the cells are collected into little clusters, and their contents are nucleated. Meneghini, therefore, would not appear to have studied the second species of his genus *P. montana*, which, as well as the other species *Palmella Ralfsii*, *P. virescens*, and *P. grumosa*, ought, in all probability, to be included in a distinct genus. *Palmella cruenta*, on the one side, evidently bears a close relation to *Protococcus nivalis*, from which indeed it principally differs in the fact of the globules being distinctly immersed in gelatine, while in *P. nivalis* they are free. *P. montana*, &c., on the other hand, exhibits a relation almost as close to *Hæmatococcus*, from which genus it differs in the same manner as *Protococcus nivalis* and *Palmella cruenta* differ. The globules of *Hæmatococcus sanguineus* exhibit the same nucleated appearance as do those of *P. montana*, *P. Ralfsii*, &c.

1. Palmella cruenta *Ag.*

Plate LXXX. Fig. 5.

Char. Frond *indefinite, crustaceous, expanded, blood-red, tuberculate, filled with subangular hyaline globules, and "very minute punctiform scattered granules."*

Tremella cruenta, E. Bot. t. 1800.; Grev. Crypt. Flor. p. 205.; Hook. Brit. Flor. vol. ii. p. 396.; Harv. in Manual, p. 179.

Hab. On damp walls, chiefly such as are whitewashed; often in cellars. Glasgow: *Sir W. J. Hooker.* On damp walls near the ground at Mayfield and elsewhere, frequent: *Mr. Jenner.*

"The red spots in the beginning irregularly orbicular, quickly becoming confluent, attached to earthy particles, to stones, and other extraneous substances, form a widely expanded crust, which, on the application of moisture, swells up, and then especially resembles coagulated blood. By drought their young frond grows dusky and disappears; but more evolved, it dries up, and is more intensely coloured; it cracks, curls up, and falls in pieces. Rainy weather continuing, and other *Algæ* being evolved amongst it, especially *Oscillatoria autumnalis* and *Microcystis atrovirens*, it becomes green, and at length black. If the crust be kept immersed some hours in water, it swims on the surface like a thin pellicle. A morsel of this subjected to the microscope presents hyaline globules, subangular, and adorned with a faint carneous tint, which are so closely heaped together, that at first sight they appear to form a cellular membrane. Nevertheless they are not joined by any adherence, as is evident from the fact that they recede from each other under the object glass itself with the slightest pressure. The mucous, colourless substratum and punctiform granula or lesser globules, more intensely coloured, then come into sight. Moreover, a fragment of the frond itself, first submerged in water, submitted to microscopic examination, manifests the same organs, though less appressed, and the mucous substratum, endowed with more consistence, is detected."

46. SOROSPORA *Hass.*

Char. Cells *nucleated, associated in clusters.*

Derivation. From *σωρος, a cluster* or *mass,* and *σπορα, a seed.*

1. Sorospora montana *Hass.*

Plate LXXIX. Fig. 1.

Char. Frond *between coriaceous and gelatinous, irregular, much and variously lobed, curled, dark purple.* Granules *crowded, in clusters composed of six or eight granules each.*

P. alpicola Lyngb., Hydroph. p. 2067. ap. 69. *Ulva montana* Light., Scot. Flor. p. 973. *Ulva montana* Hudson, Flor. Ang. p. 652. *Ulva montana* Withering, Arrangement of Br. Pl. vol. iv. p. 122.; Smith, E. B. t. 2193.; Harv. in Hook. Br. Flora, p. 396., also in Manual, p. 179.

Hab. On mosses and lichens on the summits of rocks. On the mountains of the Isle of Skye, and west coast of Scotland; Glen Cateol: *Dr. M'Culloch.* Lying on the ground but not attached to it, in stony moist places on Goat Fell, Arran: *Sir W. J. Hooker.*

According to Lightfoot, this is the "Mountain Dulse" of the Scotch.

"On the mountains of Arran this lies unattached among loose wet stones, covering them in a straggling manner to a considerable extent. Each frond is an inch or an inch and a half in diameter, flattish, somewhat orbicular, between coriaceous and gelatinous; when dry almost horny, of a deep but dull purple colour, much lobed and curled, like some *Gyrophoræ,* filled with crowded clusters of granules, which, if minutely examined, are found to be arranged mostly in fours." — *Hook.*

2. Sorospora Ralfsii *Hass.*

Plate LXXIX. Fig. 3.

Char. Frond *minute, thin, gelatinous, hyaline, somewhat areolate; each* areola *containing* 2—8 *large, globose, blood-red granules.*

Palmella Ralfsii Harv., in Manual, p. 179.

Hab. Spreading over mosses on Cader Idris: *Mr. Ralfs.*

"*Fronds* a few lines in diameter, gelatinous, somewhat areolate, or as if composed of numerous small vesicles massed together, each of which contains 2—4 or eight large blood-red granules, which are much larger and of a far deeper colour than those of *P. montana.*" — *Harv.*

In the specimens which I have examined of this species, the granules in each cluster have been usually not less than six or eight, and between the clusters faint divisions of the mucous matrix may be discerned, which increases still further the resemblance which this and the preceding plant bear to *Hæmatococcus*, and especially *Hæm. sanguineus.*

3. Sorospora virescens *Hass.*

Plate LXXVIII. Fig. 8. a.

Char. Frond *green.* Cells *in clusters, nucleated, globose.*

Of this species I have seen but a very small fragment; there can be no doubt, however, I think, of its distinctness: each cell is imbedded in a distinct cavity of the mucous matrix, the outline of which may be distinctly traced subsequent to the removal of the cells.

4. Sorospora grumosa *Hass.*

Plate LXXX. Fig. 7.

Char. Frond *widely expanded, clotted, brick-red, floating.* Globules *usually binate, globose, blood-red, and surrounded by a narrow pellucid limbus, occasionally aggregated.*

Palmella grumosa Carm., MS. *P. grumosa* Harv., in Manual, p. 180.

Hab. On a rock at the sea side in a small cavity filled with rain water at Appin: *Captain Carmichael.* West of Ireland: *M^c Colla.*

This species would appear to be somewhat anomalous, agreeing, in the fact of the globules being immersed in a distinct gelatinous matrix, with the genus *Palmella*, and according with *Hæmatococcus* in the circumstance of these being surrounded with a pellucid margin, and also in its reproduction: not, however, that it is ascertained that the reproduction of *S. grumosa* is really distinct from *Hæmatococcus.* It therefore connects these two genera closely with each other. In drying the brick-red colour of the frond changes to a dirty green, with a slight degree of gloss upon its surface.

47. COCCOCHLORIS *Spreng.*

Char. Frond *mucous, definite, at a later period often effused, in which are imbedded the* globules, *filled with matter mostly green and granular, to be converted into* vesicles *replete with globules, and producing new fronds.*

Derivation. From *κοκκος, a berry,* and *χλωρος, green.*

The following observations on *Coccochloris,* which would appear to be a tolerably well established genus, occur in Meneghini's "Monographia Nostochinearum," pp. 57, 58.

"Globuli, in substrato mucoso nidulantes, materie granulari farciuntur. Non tamen omnes ad evectiorem evolutionem perveniunt; nonnulli enim tantum majores dimensiones consequuntur, eorumque interior substantia in distinctos globulos confirmatur; globuli hujusmodi propagatione inservientes vel ad superficiem tantum frondis reperiuntur vel inordinatæ et sparsæ in quâcumque frondis regione evolvuntur. In primo illo casu a fronde matricali facile extricantur et totidem novas frondes constituunt quibus ita definita forma semper inest; in secundo verò primordia illa novarum frondium a

mucoso frondis matricalis substrato obvoluta et impedita extricari nequeunt et ibidem evolvuntur usque dum tandem eodem dissoluto et evanido libere disseminantur. In primis illis frons, totâ vitâ perdurante, semper definita remanet: in his primum definita quidem est, sed ab initio usque effunditur et dissolvitur. Differunt itaque *Coccochlorides* a *Palmellis*, in eo quòd granula in sinu globulorum ipsorum gignuntur et evolvuntur, proptereaque frons definita hic necesse inest, dum illæ eodem necesse carent; et quamquam serius in multis quoque *Coccochloribus* frons ipsa effundatur, origine tamen summopere ab illa *Palmellarum* differt. Ita ut *Palmellæ Protococcos* in muco indefinito nidulantes representant, sic *Coccochlorides* a *Chlorococcis* in fronde mucosâ definitâ inclusis efformatæ dici possunt."

1. Coccochloris protuberans *Spreng.*

Plate LXXVI. Fig. 7., and Pl. LXXXII. Figs. 6, 7, 8, 9, 10.

Char. Fronds *green, gelatinous, soft, irregularly lobed, spreading, confluent.* Globules *elliptical, generally more obscure towards the centre.* Vesicles *of various sizes, spherical or elliptical, constantly surrounded with a diaphanous margin.*

Ulva protuberans Smith, E. B. t. 2583. *Palmella protuberans* Grev., Flor. Edin. p. 323.; Crypt. Fl. t. 243. f. 1. *Palmella protuberans* Ag., Syst. p. 14.; Hook. Br. Fl. vol. ii. p. 396.; Harv. in Manual, p. 176. *Coccochloris protuberans* Spreng., Syst. Veg. vol. iv. p. 373. *Palmogloea protuberans* Kützing, Phy. Gen. p. 176.

Hab. Sussex, spring to autumn: *Mr. Borrer.* Camsie Glen, near Glasgow: *Sir W. J. Hooker* and *Dr. Greville.* Pentland Hills: *Dr. Greville.* On the ground at Crowborough Warren: *Mr. Jenner.* Co. Wicklow: *Mr. Moore.*

"The *fronds* in the beginning roundish, of very variable magnitude, quickly run into a mass more or less extensive, investing surrounding bodies or spreading over the naked soil.

Its substance, in the beginning watery and pellucid, becomes at a later period firmer and more intensely green. The frond itself, subjected to the microscope, differs very considerably in the different states of its developement. When it is green and firm, the *globules* scarcely vary at all in dimensions, but generally stand at the one hundred and twenty-fifth part of a millimetre in the greatest diameter, and their form always oblong, varies from elliptical to irregularly angular. Their interior substance appears obscurely granular, and is always more opaque in the centre. The *vesicles* are variable in form and magnitude; the smaller are mostly spherical, the larger elliptical, all constantly surrounded by a hyaline border. The smallest of all only differ from the other globules in their spherical form and diaphanous margin; and the most nevertheless attain the fiftieth part of a millimetre in diameter, and the largest have the twentieth part in their greatest diameter. The larger these are, the more manifestly granular is the structure of the interior substance: when enclosed they scarcely equal the thousandth part of a millimetre. The diaphanous margin is equally manifest both in the smaller and greater vesicles, and preserves the same proportion. In the more delicate fronds, and those having less consistence, being almost watery, the mass itself is constituted of a colourless thin mucus, in which the oblong cylindrico-elliptical, or rarely spherical globules, reaching from the two hundredth to the one hundredth part of a millimetre in their greatest diameter, hyaline or diluted green, scattered here and there, appear, with areolæ intensely green, presenting a definite suborbicular, or but irregular form, constituted of firmer and more intensely coloured mucus, and filled with subrotund globules, varying in diameter, from the thousandth to the two hundredth part of a millimetre, and surrounded with a narrow diaphanous margin. Intermediate forms are sometimes noticed, in which the mass itself, more diluted and watery, gradually disappears, and the green areolæ increased in size, and at length confluent, assume finally the characters of the older fronds." — *Menegh.*

2. Coccochloris muscicola *Menegh.*

Plate LXXVIII. Figs. 3 a. 3 b.

Char. "Frond *mucous, indefinite, very slender, investing mosses, blackish green; the smallest* globules *perfectly spherical, green, generally germinate.* Vesicles *elliptical, the larger entirely filled with lesser globules, and not surrounded with any margin.*"

P. hyalina, B. *muscicola* Harv., Manual, p. 177.

Hab. Aberdeen: *Dr. Dickie.*

"The mucous pellicle, blackish green, shining, covers extensively mosses, and at the same time includes with our *Coccochloris, Oscillatoria autumnalis* and *Nostoc lichenoideum,* the *Coccochloris globules* scarcely measuring the three-thousandth part of a millimetre, imbedded in a soft and easily yielding mucus, in which are mixed, scattered elliptical vesicles, varying in dimensions from the hundredth to the twenty-fifth part of a millemetre, entirely filled with smaller globules closely heaped together. The *vesicles* themselves are seen to be constituted of a very slender membrane, which embraces them, but not presenting a diaphanous margin, and which by laceration is scarcely to be perceived: when the membrane has been ruptured, the contents of the globules escape into irregular angular heaps. The vesicle from which the globules have proceeded is not apparent: this however is certain, that the globules are not surrounded by any peculiar membrane.

"The vesicles effused into irregular areolæ resemble the beginnings of new fronds, which, evolved in the mucous matrix, and quickly becoming confluent, form a mucous pellicle. Hence the frond is said to be indefinite, although, in the beginning, as in all other species of this genus, it is definite. This species agrees in habit with *Coccochloris protuberans,* but in structure and microscopic characters it exhibits greater affinity with *Coccochloris parietalis,* as will be shewn hereafter."

In drying, it leaves but a mere stain upon the paper, most evident at the margins of the frond.

3. Coccochloris hyalina *Menegh.*

Plate LXXVIII. Figs. 2 a. 2 b.

Char. Frond *gelatinous, cylindrical or globose, solitary, subhyaline; internal* globules *globose, very minute, green.*

Palmella hyalina Lyngb.; Grev. Scot. Crypt. Fl. t. 247.; Harv. in Hook. Brit. Flor. p. 397.; Harv. in Manual, p. 177.

Hab. Bogs at Fisher's Castle, Tunbridge Wells: *Mr. Jenner.*

Lyngbye describes this species as follows: — "Mass gelatinous, cylindrical, solitary, solid, floating on the surface of water, an inch or two long, colour commonly watery, pellucid, except as regards that which is owing to the internal granules, which are of a delicate green colour. Substance in the highest degree lubricous, adheres, in drying, to paper." Brebisson, however, states that it attains to the remarkable size of one or two feet in length, and from six to eight inches in thickness.

"Specimens communicated liberally by Cl. Brebisson and Lenormond are five inches long, and although closely adherent to paper, yet manifest greater solidity of the superficial stratum over the internal substance. For being lacerated by compression, they exhibit the interior effused substance hyaline, and the exterior pellicle more intensely coloured and opaque, and divided into irregular fragments. In the interior substance uniform, very minute *globules* are imbedded, scarcely measuring the two thousandth part of a millemetre; but the exterior pellicle is constituted of globules somewhat larger, covering a diameter of the two hundred and fiftieth part of a millimetre, in which oblong *vesicles*, altogether filled with minute globules, from the twentieth to the twenty-fifth part of a millimetre long, are mixed."

What appears to me to be at least a variety of this species was sent to me by the Rev. M. J. Berkeley. The fronds were globose, but smaller and less solid than those of *C. hyalina* in its usual state, and the globules larger. See Pl. LXXVIII. fig. 5.

4. Coccochloris depressa *Menegh.*

Plate LXXVIII. Figs. 4 a. 4 b.

Char. "Fronds *subhemispherical, depressed, green.* Granules *globose or irregular.*" — Berk.

Palmella depressa Berk., Glean. p. 19. t. 5. f. 4.; Harv. in Manual, p. 178.

Hab. Growing on an old pump at Cotterstock, Northamptonshire, and constantly moistened by the dripping of the spout.

"The irregular granules, some of them larger than others, and many being agglomerated together, and comprehended in a common integument, as depicted by the author, have led to this generic collocation of this species. The comparison also which the author of this species instituted with the *Palmella terminalis* Ag. appears to sustain this opinion."—*Menegh.* When dried the frond is destitute of gloss.

5. Coccochloris Mooreana *Hass.*

Plate LXXVIII. Figs. 1 a. 1 b.

Char. Fronds *large, globose or lobed, of a rich dark æruginous green colour, unaltered in drying, and of firm substance.* Globules *oval, small, tolerably uniform in size and shape.*

Palmella Mooreana Harv., in Manual, p. 178.

Hab. In a boggy hole at Shane's Castle, the seat of Lord O'Neill, near Lough Neagh: *Mr. D. Moore.*

"The fronds are of an irregular globose form, about an inch in diameter, tuberculated, and inclining to become hollow in the centre when old, at which time it floats on the surthe colour is dark green, and the substance firm, resembling that of an animal's liver."—*Moore's MS.* The rich æruginous green colour of this species, resembling that of many *Oscillatoriæ*, affords a character whereby at once this species may be distinguished from all its congeners. The

fronds adhere closely to paper, present considerable gloss, and retain the freshness and depth of their colouring when dried.

"I have much pleasure in ascribing it to its acute discoverer Mr. D. Moore, curator of the Royal Dublin Society's Botanic Garden, who has added so many interesting plants to the Irish Flora."—*Harv.*

Having only had the opportunity of examining dried specimens, I am not able to give the measurements of the globules and vesicles; I have, however, been able to ascertain sufficient of the species to render it quite certain that the reference to the genus *Coccochloris* is correct. The same remark applies to the other species which I have placed in that genus.

6. Coccochloris rivularis *Hass.*

Plate LXXVIII. Figs. 6 a. b.

Char. Fronds *hemispherical, tuberculose, often confluent, bright green when recent, turning to brown in drying.* Globules *small, globose, scattered.*

Palmella rivularis Carm., MS. *P. rivularis* Harv., in Hook. Brit. Flor. p. 397.; Harv. in Manual, p. 177.

Hab. In a mountain streamlet, attached to rocks and stones, Appin: *Captain Carmichael.*

"*Fronds* one fourth or half an inch in diameter, hemispherical, tubercular, firmly adhering, sometimes cohering into a broad crust. *Granules* small, globular, scattered. *Colour* vivid green. It bears a striking resemblance to *Chætophora tuberculosa.*"—*Carm. MSS.* In drying it shrinks considerably, and fades to dirty brown.*

* In a specimen which I have lately examined of this species, I distinctly perceived divisions in the mucous substance; a certain number, usually two, of the granules, as in the genus *Hæmatococcus*, being invested with a separate portion of the general substance. It is probable that this structure belongs to all the species of the genus, and possibly of *Ulva* also.

7. Coccochloris Grevillei *Hass.*

Plate LXXVIII. Figs. 7 a. b. 8.

Char. Fronds *minute, densely crowded, globose or somewhat lobed, green, decidedly gelatinous.*

a Granules *elliptical.*

β Granules *small, globose.*

γ Frond *smaller, more hyaline, and with larger globose* granules.

Berk. Glean. Br. Alg. p. 16. t. 5. f. 1.; Harv. in Manual, p. 177. *Palmella botryoides* Grev., Crypt. Fl. t. 243. f. 2.; Harv. Hook. Brit. Fl. l. c. p. 396.—*β. P. botryoides* Lyngb., Dan. p. 205.—*γ.* Berk., Glean. t. 5. f. 2.

Hab. On heathy places, moist situations, frequent: *γ* on decaying stems of *Asparagus officinalis*; in a hotbed: *Rev. M. J. Berkeley.*

"*Fronds* minute, densely crowded, globose, green, composed of pale green jelly, in which are numerous darker granules, elliptic in var. *a*; in var. *β* globose, and accompanied with smaller globose granules, collected more or less into little rounded heaps, the longest of which are of the size of the larger granules. After it has been dried, the jelly is nearly colourless, and the granules are scattered, and all of the same size."—*Rev. M. J. Berkeley.*

It is evident from the preceding description that more than one species is included under the name of *Palmella Grevillei.*

Note. I have since paid further attention to the subject of the division of the mucous matrix into vesicles or cysts in *Coccochloris*, and I now find that this structure is to be met with only in certain species of the genus, and that it cannot be detected in any of the species figured in this work. The species, therefore, with the frond thus divided, connect *Coccochloris* with *Hæmatococcus*, and scarcely differ from those of the latter genus.

It is still probable that the structure really does belong to all the *Coccochlorides*, but that the extreme delicacy of the organization of some of the species prevents its detection. Ramifying throughout the substance of the fronds of all the species may be observed numerous slender branched tubes, which may either be parasitic growth, or else form part of the organization of the fronds; and in the latter case they may be presumed to be connected with respiration.

Fam. XVIII. PROTOCOCCEÆ.

Char. Stratum *indefinite, friable, formed by an aggregation of distinct* globules, *which, not being immersed in gelatine, and not enclosed by a common investing membrane, are readily separable from each other on the application of moisture.*

48. BOTRIDINA *Breb.*

Char. " Frond *gelatinous, globose, at a later period entirely constituted of* vesicles *enclosing* granules; *at length the internal vesicles being absorbed, and the outer cellular membrane defined, including granules imbedded in mucus.*"

Derivation. The diminutive of *βοτρυς, a bunch.*

Obs. " Cl. Brebisson humanissimis literis observationes suas communicavit, quibus innixus novum hoc genus proposuit, has ipsas maxima pro parte et nos ipsi veritate apprime respondentes invenimus. In hoc tamen nostra differt sententia, quòd granula secundum Cl. Brebisson in alveolis tantum peripheric is sita, nobis contra in alveolis cum peripheric is tum interioribus initio nidulari videantur, sed alveolis sine vesiculis illis interioribus serius resorptis, et peripheric is tantum iisdemque vacuis, membrana efformatur globulos jam evolutos et propagatione aptos muco obvolutos includens. Nomen a Cl. Brebisson propositum, legibus glossologiæ non omnino concisum, delere ausi non sumus." — *Meneghini.*

This genus resembles somewhat in structure the compound pollen granules of many plants.

Note. The *Anacystis furfuracea* Menegh., a production very different from the *Palmella furfuracea* Berk., with which Meneghini supposed it identical, and one coming near to *Botridina*, is a British *Alga*. I have more than once met with it.

1. Botridina vulgaris *Breb. in lit.*

Plate LXXXI. Fig. 2.

Char. "Fronds *small, spherical, aggregated, often confluent, green, solid, with minute globose or subangular globules.*"

"*Nostoc botryoides* Ag., Syn. p. 135. *Palmella botryoides* Lyng., Hydrop. p. 205. No. 6.; Ag. Syst. p. 14. No. 5.; Grev. Scot. Crypt. Fl. t. 5. No. 243.? *P. Grevillei* Berk., Glean. vol. i. p. 16. t. 5. f. 1.—?"—*Meneghini. Botridina vulgaris* Meneghini, in Monograph. Nostochinearum.

"The *fronds* of various sizes, rarely surpassing the head of a pin, of a subspherical form, aggregated in considerable quantity, cover the stems of mosses with a pulverulent blackish green stratum, which Agardh first well delineated. The *granules* in the beginning solitary, here and there affixed subspherical or slightly angular, scarcely equal in their greatest diameter the five hundredth part of a millimetre; gradually they increase in size, and when they have arrived at the two hundredth part of a millimetre, they manifest an internal granular substance; at a later period having acquired a form exactly spherical, the internal substance is seen aggregated or collected into the centre, and the granules surrounded by a pellucid margin. Again they increase in size, and the interior *granules* are seen converted into *vesicles* filled with lesser granules. These vesicles increased in number and magnitude, the greatest dimensions of the frond being attained, occupy its entire substance, and at length the diaphanous margin disappears. The whole frond is then constituted of vesicles closely heaped together, and enclosing in the centre granules. The primitive membrane, enclosing in its midst the interwoven or cellular structure, is so closely united with the peripheral stratum of vesicles, that it can in no way be separated from it. The last developement having been accomplished, the peripheral stratum of vesicles altogether looses its granules: whether these disappear by absorption, or escape outwardly, I have never been able to perceive. In this man-

ner the frond again obtains a diaphanous margin, but different from that with which in the beginning it was surrounded."—*Menegh.*

49. HÆMATOCOCCUS *Ag.*

Char. Cells *spherical or oval, of various sizes, each invested with one or more concentric vesicles or membranes, multiplied either by division or by granules formed within the parent cells.*

Derivation. From *αἷμα, blood,* and *κοκκος, a berry.*

Agardh has evidently included in his genus *Hæmatococcus* productions generically distinct; as, for example, *H. sanguineus* and *Hæm.* or properly *Protococcus nivalis:* he therefore would appear not to have entertained any precise ideas in reference to his genus beyond the fact of the contents of the cells of some of the species being of a red colour. Meneghini in the memoir so often referred to, limits the genus *Hæmatococcus* to one species, the *H. nivalis* of Agardh, a production which assuredly does not differ even specifically from the *Protococcus nivalis* of the same author, and constitutes a new genus *Microcystis* for the reception of *H. sanguineus* and its allies, the adoption of which, as *H. nivalis* Ag. cannot be allowed to remain in that genus, is rendered unnecessary.

Of the two terms *Hæmatococcus* and *Microcystis*, the latter is by far the more applicable, the former being in some degree objectionable, inasmuch as it is founded on the colour of the globules, a colour confined to a limited number of the species of the genus. Meneghini thus defines his genus *Microcystis:* —

"*Frond* mucous; in the beginning definite, at a later period effused, including *globules* clothed in *vesicles* and multiplied by a quaternary division or by *granules* evolved within, constituting so many new fronds."

"Each globule, in the same way as those of the *Pleurococci*, shrinks from its involucre, and then appears to be clothed with its proper vesicle. A process of this kind is frequently

repeated, and hence arise so many concentric vesicles enclosing the small globule in the centre.

"Frequently the globule, having shrunk from its proper envelope, is divided into half, and each half, having shrunk from its investing vesicle, again is divided into two parts, and this occurs many times in succession. At length, the vesicles being torn or converted into mucus and absorbed, the globules themselves formed by division are poured out into the common mucous substratum. At other times the primitive globules, or more frequently the internal substance of the second, the usual division being suspended, passes into very minute granules, and the involucre of the globule itself converted into mucous substance, gives birth in the same manner to new globules. The frond in the beginning indeed definite, nevertheless speedily becomes confluent, and indefinitely expanded. This genus, therefore, differs only from *Coccochloris* in the division of the globules, which likewise manifests an affinity to *Pleurococcus*." — *Meneghini.*

The species included by me in the genus *Hæmatococcus* admit of division into three subgenera. They embrace also the genera *Microcystis* and *Pleurococcus* of Meneghini, to distinguish which genera I can find no satisfactory character.

First Subgenus. — Globules *appendaged, that is, each terminates or is imbedded in the extremity of a distinct mucous prolongation, the mass of the plant being formed principally of these mucous prolongations.*

The term *Ouracoccus* might be applied to the species of this subgenus.

a. Mucous prolongation *plain.* Granules *invested with a single vesicle.*

1. HÆMATOCOCCUS ALLMANI *Hass.*

Plate LXXX. Fig. 3.

Char. Globules *elliptical, large, blood-red, surrounded by a single diaphanous margin.*

Hab. Dropping Well, Knaresborough: *Prof. G. J. Allman.*

The globules of this species resemble in size and form those of *Coccochloris murorum*, a species which might indeed be referred to the genus *Hæmatococcus*, it differing from *Hæm. Allmani* only in colour, and in so far as I can ascertain, the absence of the mucous appendages. If these ever be present in *Coccochloris murorum*, then there can be no doubt of the generic identity of the two plants.

Not being able to find that this plant has as yet been recorded, I have great pleasure in naming it after my friend Dr. Allman, from whom alone I have received the plant. The specimens sent, although very fine, were not altogether free from admixture, being mixed up with examples of *Hæm. Hookeriana*. It was on an examination of these specimens that I first discovered the mucous appendages, of which I immediately apprised Dr. Allman, who wrote to me as follows: —"Many thanks for your information. Your observation on the structure of the *Algæ* I sent you is most interesting. Though I distinctly enough detected a peculiar organization in the gelatinous flesh in which the capsules of the *Alga* with red granules are imbedded, I saw nothing of the singular arrangement you mention. Your observation is certainly most interesting and original. I am longing to examine the *Alga*, now that you have directed my attention to the curious fact you mention." The granules vary much in size in this as well as in all other species of the genus *Hæmatococcus*. The *Hæm. sanguineus* of Kützing may possibly be referrible to this, or perhaps more probably to the *Hæm. cryptophila*, as it is described as having elliptical granules.

2. HÆMATOCOCCUS MURORUM *Hass.*

Plate LXXXI. Fig. 4.

Char. Granules *elliptical, æruginous green, free, surrounded by a band, pellucid limbus.*

Coccochlorum murorum Grev., Scot. Crypt. Fl. t. 6. No. 325. *Microcystis mellea?* Menegh., loc. cit. t. xii. fig. 2.

Hab. Scotland: *Dr. Greville.* Ireland: *Mr. Moore.*

The cells of this species precisely resemble those of *H. Allmani* in form and size, the only difference being that of colour, and the absence of the mucous elongations. It ought, assuredly, to be regarded as congeneric with *H. Allmani*. In a specimen from the herbarium of Sir W. J. Hooker, the granules were not, as in other specimens which I have examined, exactly cylindrical, but somewhat pointed at one extremity.

May 14. 1845. — I have just detected mucous appendages in this species similar to those of *H. Allmani*.

3. Hæmatococcus cryptophila *Hass.*

Plate LXXX. Fig. 1.

Char. Granules *blood-red, small, usually oval.*

Palmella? cryptophila Carm., MS. cum icone. *Hæmatococcus sanguineus*, in part, Harv. in Manual, p. 181.

Hab. On a stalactitic incrustation lining the vault of a cavern in a quartz rock, Appin: *Captain Carmichael.*

This forms wide patches, externally of a brick-red colour, but within whitish, breaking up easily into the numerous separate portions of which each mass is formed. The reason of the red colour being confined to the external surface of the crust results from the structure and mode of developement of the species of this genus. The colour resides alone in the granules: these terminate the superior extremity of the mucous prolongations, which are colourless, and arranged almost entirely side by side. The granules or cells are several times smaller than in *H. Allmani*.

b. Mucous prolongations *transversely corrugated or ringed.* Granules 1—2 *in each cell, spherical.* Vesicles *numerous.*

4. Hæmatococcus insignis *Hass.*

Plate LXXX. Figs. 6 a. 6 b.

Char. Granules *very large, spherical, blood-red.*

Hab. England.

This very fine species I have never met with in any considerable quantity. Scattered isolated globules I have frequently met with, and these occasionally attached to a closely corrugated or ringed mucous appendage. Each globule is usually surrounded by a single vesicle or ring: in some globules, however, there are as many as four or five enclosing vesicles.

5. HÆMATOCOCCUS HOOKERIANA *Berk.* and *Hass.*

Plate LXXX. Fig. 4.

Char. Granules *very small, spherical, blood red, surrounded by one or more investing membranes or vesicles.*

Hab. On a chalk cliff at Mundley, Norfolk: *Sir W. J. Hooker.* Dropping Well, Knaresborough: *Dr. Allman.*

Shortly after noticing this species in beautiful condition, mixed up with *H. Allmani*, but which had altogether escaped the notice of Dr. Allman, I received a dried specimen of this plant, accompanied by a description and remarks on the ringed organization of the mucous appendages from the Rev. M. J. Berkeley, to whom it had been communicated for examination by Sir W. J. Hooker. Specimens of *H. Allmani* and *H. Hookeriana* were then sent to Mr. Berkeley, who satisfied himself of the identity of Dr. Allman's specimen with that transmitted to him by Sir William Hooker. The only difference between the specimens collected in habitats so widely different was, that in the former the transverse corrugation of the sheath was the more conspicuous.

The Rev. M. J. Berkeley, in his first letter, thus speaks of it:—"I have just received the enclosed from Sir W. J. Hooker. It does not agree with any of Meneghini's species of *Microcystis*. There is a very curious appearance in some parts as if the old vesicles were chained together." In a second communication, Mr. Berkeley adds—"I have not had time to examine your *Alga* till to-day: it is certainly the same as Sir W. Hooker's, but far finer; the threads are three or four times as long. I still fancy my theory, as to their origin, is right."

Second Subgenus. — Mucous appendage *wanting.* Granules *one, two, or four, in each cell.*

Obs. It is possible that subsequent research may prove that one or more of the species of this section should be referred to the first subgenus.

a. *Investing* vesicles *numerous.*

6. HÆMATOCOCCUS RUPESTRIS *Hass.*

Plate LXXXII. Fig. 1.

Char. Granules *spherical, olive green, single, sometimes binate, very small, each enclosed in several distinct enveloping vesicles.*

Palmella rupestris Lyngb., Hydroph. p. 207. t. 69. D. *P. rupestris* Ag., Syst. p. 13. *Microcystis rupestris* Kütz., Linnæa, p. 374. No. 9. *Microhaloa rupestris* Kützing, Phycologia Generalis, p. 169.; Harv. in Hook. Br. Flora, ii. 397.; also in Manual, p. 178.; Meneghini loc. cit.

Hab. On moist overhanging cliffs, Appin: *Capt. Carmichael.* Aberdeen: *Dr. Dickie.* On moist conglomerate sandstone caves near Cushendall, co. Antrim: *Mr. Moore.*

"*Frond* hyaline, gelatinous, yellowish green, easily broken up, about an inch in diameter, shapeless, rough; pellucid, more dense in the centre and elevated; when dried, collapsed; blackish, cartilaginous, fragile. Subjected to the microscope, it appears constituted of hyaline subspherical *vesicles*, enclosing yellowish green, spherical or slightly oblong *globules*, usually undivided. Solitary globules, magnified with glasses less powerful, are seen free and naked; by means of a more powerful microscope, almost all are perceived to be clothed with a proper cyst, larger vesicles enclose smaller, and the whole frond appears areolated, the hollow areolæ containing solitary or binate globules. The vesicles, general as well as partial, duplex, triplex, or multiplex, and that without

any perceptible order, commonly present concentric circles, generally approximated, evident to the light. But the quaternary type, both in the distribution of the vesicles and globules, is generally preserved. The diameter of the globules is constant at the two hundredth part of a millimetre; that of the vesicles varies from the hundredth to the twenty-fifth part of a millimetre.

"At a more advanced period of growth, some globules become thicker, and manifestly include a granular substance, the partial vesicles at the same time becoming dissolved, and disappearing. Towards the circumference of the frond are often noticed globose, elliptical, or irregularly lobed areolæ, which are seen to be gelatinous, and all filled with very minute granules scarcely the fiftieth part of a millimetre in size. It appears, therefore, that each one of the larger vesicles, the partial vesicles included by it being absorbed, the globules having been converted into granules, is changed into a new frond. As often as a fragment of the frond is compressed between plates of glass, the oblong gelatinous bodies enclosing very small granules, which we regard as new and incipient fronds, and which are always present in great abundance, are lacerated, their contents poured forth, and they then cover the other parts with the thin mucus with which they are themselves enveloped; and from this C. Kützing appears to have asserted that the vesicles were enfolded, the green stratum enclosing very minute granules. It is yet remarkable that the multiplied and concentric vesicles escaped the celebrated Kützing and the acute Lyngbye." — *Meneghini.*

7. Hæmatococcus granosus *Harv.*

Plate LXXXI. Fig. 6.

Char. Crust *widely spreading, granulated, pale green.* Cells *polymorphous, formed of two or three vesicles, and each containing one, two, or four green, large, elliptical* granules *with distinct hyaline borders.*

Palmella granosa Berk., Glean. Brit. Alg. ii. p. 19. *Microcystis granosa* Meneghini, l. c. p. 85.

Hab. Growing in great abundance on sub-immersed *Hypnum stellatum*, in the bogs bordering on Whittlesea Mere, summer: *Rev. M. J. Berkeley.* Aberdeen: *Dr. Dickie.* Broadwater Forest: *Mr. Jenner.*

" Pale green, or when preserved in the herbarium, with a pale brownish tint. Growing in large masses of no certain or distinct form, but broken into many angular faces, having a very granulated appearance, and crumbling beneath the fingers. The whole plant is made up of sub-elliptic, hyaline, colourless, jelly-like bags, containing from two to four green elliptical granules, which in some lights appear as if surrounded with a pellucid border." — *Berk.*

Meneghini makes the following remarks on this fine species: " Hic auctor monet speciem hanc præter colorem *Hæmatococco sanguineo* Ag. simillimam esse; et ejusdem affinitate cum *Palmella rupestris* animadvertens limites generum Hæmatococcus et Palmella incertos esse demonstrat, summo nempe acumine novi generis Microcystis instituendi necessitatem præsenserat."

b. *Usually but one investing membrane or* vesicle.

* Granules *from one to eight.*

8. HÆMATOCOCCUS ALPESTRIS *Hass.*

Plate LXXXI. Fig. 3.

Char. Globules *of very variable size, often large, rarely concentric, containing one, two, four, or eight, but usually two or four small, spherical, dark green* granules.

Pleurococcus glomeratus? Menegh., loc. cit. t. v. f. 2.

Hab. Wales: *Sir W. J. Hooker.*

On looking over the splendid collection of *Algæ* forming part of the herbarium of Sir W. J. Hooker, I noticed a

specimen of a dark olive compact substance two inches in extent, marked *Tremella*. This, on examining with the microscope, I soon ascertained to belong to the present genus, of which it forms a remarkable species — one remarkable for the size of the vesicles, the smallness of the enclosed granules, and for the absence in general of concentric rings or vesicles.

** Granules *mostly numerous in each cell.*

9. HÆMATOCOCCUS SANGUINEUS *Ag.*

Plate LXXIX. Fig. 2.

Char. Smaller cells *spherical, containing usually one or two granules; larger, often angular, and filled with numerous blood-red, circular, and nucleated* granules.

Hæmatococcus sanguineus Ag., Icon. Alg. Europ. No. xxiv. *Palmella? sanguinea* Ag., Syst. p. 15. *Hæm. sanguineus*, in part, Harv. Manual, p. 181.

Hab. On shady rocks at Tobermorey in Mull: *W. H. Harvey.*

Mr. Harvey in his "Manual" has included in his *Hæmatococcus sanguineus* two species, the one being the *Palmella? cryptophila* of Carmichael, the other, in all probability, the true *H. sanguineus*, a production which would seem to be as rare as it is strikingly beautiful, it only having as yet been discovered in one locality by Mr. Harvey, to whom I am indebted for the specimen from which my figure is taken. The smaller cells are quite spherical, and contain but a single blood-red granule, a wide pellucid border produced by the thickness of the single vesicle which encloses it surrounding the granule: the larger attain a very considerable size, are mostly angular, and include a very considerable number of large spherical granules, each of which is occasionally surrounded by a transparent vesicle, in which state each separate granule is to be regarded as a distinct young frond enclosed in the parent cell.

10. HÆMATOCOCCUS FRUSTULOSUS *Harv.*

Plate LXXXI. Fig. 1.

Char. Crust *widely spreading, friable, dark grey.* Cells *large, roundish, containing numerous, very minute, scattered* granules.

Palmella frustulosa Carm., MSS. cum icone. *Hæmatococcus frustulosus* Harv., in Hook. Br. Fl. p. 395.; also in Manual, p. 181.

Hab. On irrigated cliffs, perennial, Appin; *Capt. Carmichael.*

Capt. Carmichael thus briefly describes this fine species:— "It occurs in the form of a greyish black fragmentary scurf On the slightest pressure it separates into corpuscles of various forms, but mostly spherical, hyaline: under the microscope, surrounded by a membranous envelope, and including several granules."

The granules are very minute, spherical, not usually surrounded by vesicles, and very numerous, the larger cells enclosing as many as one or two hundred granules.

11. HÆMATOCOCCUS ARENARIUS *Hass.*

Plate LXXVI. Fig. 10.

Char. Cells *spherical, rather small, containing spherical green* granules, *varying in number from one to ten, but usually there are five or six.*

Hab. Tunbridge Wells Common: *Mr. Jenner.*

This species approaches rather closely to the preceding, but yet may be easily distinguished from it. The cells or fronds of *H. arenarius* are much smaller, contain fewer granules, although these are larger than those of *H. frustulosus.*

*** Granules *frequently binate or quaternate.*

The granules in all the species of the genus *Hæmatococcus* are increased by division, the division not usually extending

to the outer membrane. The cells, the youngest of all, contain but a single granule: as the developement proceeds, this becomes divided into two other granules, and these are again subdivided, and so on the process of multiplication proceeds, in some cases, as in *H. sanguineus* and *H. frustulosus*, to a much greater extent than in other species.

12. HÆMATOCOCCUS BINALIS *Hass.*

Plate LXXXII. Fig. 2.

Char. Cells *large, elliptical, green, each containing mostly two semi-elliptical* granules.

Pleurococcus thermalis ? Menegh., loc. cit. t. iv. fig. 3.

Hab. Cheshunt: *A. H. H.* Aberdeen, mixed up with other Algæ: *Dr. Dickie.*

This species is very distinct. Some of the cells contain but a single granule, others two, and these are by far the most numerous; others again, four granules. The species I suspect is by no means uncommon.

It is not unlikely that this is an appendaged species.

13. HÆMATOCOCCUS FURFURACEUS *Hass.*

Plate LXXXII. Fig. 4.

Char. Cells *small, spherical, or somewhat angulated.* Granules *often associated in pairs.*

Palmella furfuracea Berk., Glean. Alg. p. 18. t. 5. f. 3. *P. furfuracea* Harv., in Manual, p. 178.

Hab. Forming a thin mealy stratum of a light yellowish green, on the walls of a large frame at Milton, Northamptonshire: *Rev. M. J. Berkeley.* Limestone rocks, co. Antrim: *Mr. Moore.*

"Fronds aggregate, diffuse, irregular, granulated, rather rigid, under the knife, falling down into a mass *of minute*

more or less rounded granules with scarcely any appearance of jelly." — *Berk.*

The *Anacystis furfuracea* would appear to be an entirely different plant.

14. Hæmatococcus lividus *Hass.*

Plate LXXXII. Fig. 5.

Char. Crust *of an indefinite extent, and livid colour.* Granules *spherical, green, small, solitary or binate, and frequent, quaternate, the quaternate granules being contained in spherical cysts.*

Palmella livida Carm., in Grev. Flor. Edin. *P. livida* Harv., in Manual, p. 178. *Microcystis livida* Meneghini, Monographia Nostochinearum Italicarum, p. 74, 5.

Hab. "On overhanging cliffs, covering them to an indefinite extent with a dirty black scurf:" *Captain Carmichael.* Found on limestone rocks near Poilballintrea, co. Antrim: *D. Moore.*

The solitary and binate granules which constitute by far the greatest portion of the plant are not enclosed in cysts, and therefore do not appear to be surrounded by a transparent limb or border. The granules however when associated in pairs or multiples of that number are always enclosed in a distinct cyst or vesicle, and occasionally it happens in this as in other species of this division of the genus *Hæmatococcus,* that each of the contained granules is also furnished with a distinct envelope.

Mr. Moore writes of this species: — "This singular substance covers the overhanging limestone rocks to a great extent, sometimes as much as several hundred yards together. When fresh, it looks like a blackish brown, gelatinous substance, giving the rocks on which it grows the appearance of being covered with pitch. On places where it becomes dry by exposure to the sun, it is very friable, and on being touched crumbles down to a powder. Under the glass it is found to

be composed of excessively minute granules, pellucid in the centre with darker edges. Is it a *Palmella?*"

15. HÆMATOCOCCUS ÆRUGINOSUS *Hass.*

Plate LXXXII. Fig. 3.

Char. Stratum *æruginous green, firm.* Granules *minute, mostly solitary, and not enclosed in cysts, somewhat angular, occasionally in their ultimate developement associated in pairs or multiples of that number and contained in a globose vesicle.*

Palmella æruginosa Carm., MS.

Hab. Appin: *Captain Carmichael.*

Of this species, remarkable for the richness of its colour, I found a specimen in the herbarium of Sir W. J. Hooker. In its microscopic character, it resembles somewhat *H. lividus*, but is altogether a smaller plant.

16. HÆMATOCOCCUS THERIACUS *Hass.*

Plate LXXVIII. Fig. 9.

Char. Granules *excessively minute, mostly solitary and spherical, but occasionally enclosed in cysts.*

Hab. Rievaulx Abbey, Yorkshire: *Dr. Allman.*

This is the most minute species of the genus. Dr. Allman, who alone has noticed it, compares its appearance to that of inspissated syrup.

17. HÆMATOCOCCUS VULGARIS *Hass.*

Plate LXXXI. Fig. 5.

Char. Cells *many-cysted, of various sizes and forms.* Granules *angular, numerous in each cell, often repeatedly divided into fours.*

Pleurococcus vulgaris Menegh., Consp. p. 20. *Chlorococcum vulgare* Grev., Scot. Crypt. Fl. vol. iv. No. 262.

Hab. On walls, trees, &c., Cheshunt: *A. H. H.* Appin: *Captain Carmichael.*

Although this species is somewhat peculiar in its developement, not the slightest necessity exists for its removal from the many-cysted species of the genus *Hæmatococcus*. It is impossible to make too rigid an examination and analysis of plants of this order, but the utmost care is required in forming a right estimate of the value of the differences disclosed by a rigorous examination, for if every small difference be too highly regarded, we shall soon have genera as numerous as species. The figure given in this work is chiefly taken from that of Meneghini's "Monographia."

18. Hæmatococcus microsporus *Hass.*

Plate LXXVI. Fig. 8.

Char. Cells *angular, adherent to each other, and each occupied with usually four minute slightly oval green* granules.

Hab. Uckfield Sandrocks, Sussex: *Mr. Jenner.*

This is a distinct enough little species. I have only seen the specimens of Mr. Jenner, who sent it me as "*Palmella protuberans.*" The granules are always enclosed in cells, which are strongly adherent to each other, and never separate.

19. Hæmatococcus minutissimus *Hass.*

Plate LXXVI. Fig. 9.

Char. Globules *spherical.* Granules *excessively minute, green.*

Hab. Mixed up with *H. furfuraceus.* Ireland: *Mr. Moore.*

The granules in this species are even smaller than those of *Hæm. microsporus*, and are much more numerous in each cell than in that species.

50. PROTOCOCCUS *Ag.*

Char. Plant *consisting of aggregated, naked* globules, *filled with minute* granules, *and sessile on a gelatinous transparent mass.*

Derivation. From πρωτος, *first* or *primary*, and κοκκος, *fruit*; from its elementary organization.

"Agardh states that the globules of his *Protococcus* are perfectly *simple*, or consist merely of a hyaline cellule enclosing an uniform coloured mass, and he regards our British plant as a different species, belonging to *Hæmatococcus*. Having minutely examined a specimen from Agardh himself, submitted to me for that purpose by Dr. Greville, and finding exactly the same compound structure as in our British specimens, I do not hesitate to pronounce the two plants identical." — *Harv.*

1. PROTOCOCCUS NIVALIS *Ag.*

Plate LXXX. Fig. 2.

Char. Globules *exactly spherical, very minute, fine purple-red.* Gelatinous mass *pale, spreading.*

Grev. Crypt. Fl. t. 231.; Ag. Je. Alg. Europ. t. 21., and *Hæm. Grevillii* Ag., l. c. t. 23.; Harv. l. c. p. 395. *Palmella nivalis* Hook., in Parry's 2nd Voy. App. *Uredo nivalis* Bauer, in Journ. of Science and Arts, vol. vii. p. 222. t. 6.

Hab. On the borders of the lake of Lismore, spreading over decaying leaves, &c.: but in greater perfection on the calcareous rocks, within the reach of occasional inundation: *Captain Carmichael.* Near Miltown Malbay, on schist; Limerick, on limestone; and about Dublin on granite. In most cases slightly inundated. — *W. H. Harvey.*

This curious little plant, which, under the name of *Red Snow*, has excited so much interest among botanists, is usu-

ally found in this country in the form of a thin, stain-like stratum on the surface of rocks, or investing decayed vegetable substances with a purplish crust. On examination under the microscope, it is found to be composed of innumerable spherical bodies, seated upon a gelatinous substratum. The *globules* are of various sizes, probably depending upon age. At first they are furnished with a wide pellucid border, and contain a deep red homogeneous mass. As they increase in size, this border gradually becomes narrower, and at length altogether disappears, while the internal mass, which at first was simple, becomes broken into numerous distinct *granules* or *seeds*, which are finally discharged. *Red snow*, we are informed by Professor Agardh in his interesting memoir on the *Protococcus* *, was first observed by Dr. Saussure in the year 1760, on Mount Beven, in Switzerland, and subsequently so frequently among the Alps, that he was surprised how such a phenomenon should have escaped the attention of other travellers, especially Scheuchzer. Ramond found *red snow* on the Pyrenees, and the botanist Sommerfeldt in Norway. At the beginning of the century it was noticed on several of the mountains of Italy, along the Apennines; and in March, 1808, the whole country round Cadore, Belluno, and Feltre was covered in one night to the depth of twenty centimetres with a rose-coloured snow, a pure white snow having fallen before and after, so that the coloured snow formed an intermediate stratum. The same fact is recorded at the same time in several other Italian localities. Still *red snow* excited little attention among botanists, and had not obtained a place in our scientific arrangements until Captain Ross discovered it in Baffin's Bay, covering tracts of some miles in extent, and penetrating in some places to the depth of ten or twelve feet. The specimens brought home by this celebrated traveller were submitted to Mr. Bauer and Mr. Brown, to be examined

* Nova Acta Phys. Med. Academiæ Cas. Leop Car. Nat. Cuv. vol xii. p. 737. Translated in Grev. Crypt. Fl. vol. iv. sub. t. 231.

botanically, the latter of whom, with his usual acuteness, decided that it was "*Algarum* genus?? Confervis simplicibus et Tremellæ cruentæ quodammodo affine??" The "local habitation" thus assigned, has been acknowledged by all succeeding botanists; and Agardh has completed its history by giving it "a name."— *Harv.*

"It is to be observed, that the same wisdom which ordained the vegetable creation for the use of feeding and healing the body, hath applied it also to a moral and intellectual use, for the enlarging of our ideas, and the enlightening of our understandings. It joins its voice in the universal chorus of all created things, and to the ear of reason celebrates the wisdom of the Almighty Creator. As the heavens, from day to day and from night unto night, declare the glory of God, so do the productions of the earth; all trees and herbs, in their places and seasons, speak the same language, from the climates of the north to the torrid regions of the south, and from winter to spring and the harvest. Happiest of all is he, who, having cultivated herbs and trees, and studied their virtues, and applied them for his own and for the common benefit, rises from thence to a contemplation of the great Parent of good, whom he sees and adores in these his glorious works. The world cannot shew us a more exalted character than that of a truly religious philosopher, who delights to turn all things to the glory of God; who from the objects of his sight derives improvement to his mind, and in the glass of things temporal sees the image of things eternal. Let a man have all the world can give him, he is still miserable, if he has a grovelling, unlettered, undevout mind; let him have his gardens, his fields, his woods, and his lawns, for grandeur, ornament, plenty, and gratification, while at the same time *God is not in all his thoughts;* and let another have neither field nor garden; let him only look at nature with an enlightened mind; a mind which can see and adore the Creator in his works; can consider them as demonstrations of his power, his wisdom, his goodness, his truth: this man is greater as well as happier in his poverty, than the other in his riches. The one is but little higher than a beast, the other but little lower than an angel."— *Rev. W. Jones of Nayland.*

ALGÆ FIGURATÆ.

Fam. XIX. DESMIDEÆ.

Char. Algæ *rarely filamentous, bipartite, of a figured outline, highly mucous.*

We have arrived at length at the consideration of a most nteresting group and family of freshwater *Algæ*, the essential characteristics of which are the beautifully figured forms and bipartite composition of the fronds of the numerous species of which it is composed.

The *Desmideæ* have been the subject of considerable discussion respecting their animal or vegetable nature: the question is now, however, all but settled in favour of their vegetability. Amongst the advocates of their animal nature may be mentioned the names of Ehrenberg and Mr. Dalrymple: the observations of the latter, however, were confined almost exclusively to the genus *Closterium*.

Ehrenberg rested the claims of the *Desmideæ* to animality upon the mode of their increase by self-division, a method of multiplication which it is now known belongs to all the *Algæ*, and which, therefore, cannot be allowed to have any weight in the decision of the point in question. Mr. Dalrymple, however, in his memoir on the *Closteria**, adduces several other reasons for regarding them as animals, two only of which apply at all to the other genera of *Desmideæ*, the remainder being alone applicable to *Closterium*: — these are, first, the fact that the inner delicate membrane, which lines the outer symmetrical, and usually crescentic covering, con-

* See "Annals of Nat. Hist." vol. v. p. 415.

tracts forcibly on the application of certain reagents, the action of which cannot be considered as purely chemical; and second, that iodine does not detect the presence of starch in the cells. The former observation is equally applicable to the tender membrane which lines the cells of true *Confervæ*, while the latter remark is wanting in accuracy, for it is only when the *Desmideæ* are very young, and before the contents of the cells assume a granular appearance, that iodine does not make manifest the presence of starch; subsequently, however, when the endochrome has become granular and vesicular, starch is readily detected by means of iodine, it turning the large vesicular granules of a blue colour.

Meyen advocated the vegetability of the *Desmideæ*, and was the first to detect the presence of starch in the cells, but the accuracy of his remarks has been doubted; they are now, however, fully confirmed by Ralfs, Jenner, and the majority of recent algologists.

The *Desmideæ*, I conceive then, are to be regarded as vegetable productions, agreeing with the *Confervæ* proper, of whose vegetability there can be no question, in the following particulars.

1st. Probably in the elementary composition of the cellular tissue.

2d. In the undoubted presence of starch in the cells.

3d. In the multiplication of cells by division.

4th. In their reproduction.

The reproduction of this family has been stated by some writers to be threefold. I am disposed to think, however, that there is but one essential and true mode of reproduction. The three methods by which the *Desmideæ* are stated to be multiplied are, first, by the division of the cells; second, by bodies analogous to zoospores; and third, by true spores, formed as in the *Conjugateæ*, by the union, intermingling, and condensation of the contents of two distinct individuals. To the family *Conjugateæ* indeed the *Desmideæ* would appear to be more nearly related than to any other. The first cannot be regarded as a true mode of reproduction; it is but a continual growth, repetition, and

multiplication of cells; and while it effects the increase of the individuals of a species, does not provide against the extinction of that species when it shall have reached the termination of the brief existence allowed to it. Moreover, the cells resulting from the bisection of other primary cells have no periods of juvenescence and growth; they are produced at once fully developed and perfect in size and organization. It is the nature, on the contrary, of a true reproduction, that the bodies or organs by which it is effected should be at first minute, and subsequently pass through successive stages of developement. The second method is assuredly the usual and legitimate mode of reproduction, viz. that by bodies analogous to zoospores, while in the third the organs resulting from the union of two individuals are probably to be regarded in the same light in which Agardh viewed the similar bodies of the *Conjugateæ*, viz. as receptacles in which the zoospores are stored, and destined, as I think, not for immediate but for future use, that they are in fact hibernacula, designed to preserve the contained propagules until the vicissitudes and rigour of winter shall have passed away.

The formation of sporangia has been noticed to occur in nearly all the genera of the family of *Desmideæ*, and it is probable that it occasionally occurs in all of them. By Ehrenberg it has been noticed in different species of the genus *Closterium*, by Brebisson in *Desmidium*, by Ralfs in his genus *Tetmemorus*, and in *Staurastrum*. In the *Cylindrocystis Brebissoni*, a production placed by Meneghini amongst the *Nostochineæ*, but which seems to me to belong to *Desmideæ*, union of the cells has been observed, and it is most probable that this union is followed by the formation of sporangia.

So much for the reproduction of the *Desmideæ*: a few words may be added upon their growth. It has already been stated in the definition of the family that certain species of *Desmideæ* are filamentous. The filaments of these increase in length though not in number by the continual division of the cells, as do other filamentous *Algæ*; but in the *Desmideæ*, which are not formed of filaments, the

growth of cells is different, and approaches rather more closely to a true reproduction, which, however, it is not. Each of these *Desmidia* consists of two portions, or cells, frequently contracted at their points of junction. These segments, when they have arrived at maturity, separate from each other, and from the open extremity of each a little mucous pouch extends: this imperceptibly increases in size, and finally assumes the form and characters of the originally formed segments. This mode of formation of cells is highly curious, and it is one which may be accounted for by reference to the form and constitution of two portions of those *Desmideæ* which present it.

Another fact, not as yet alluded to, has been advanced in support of the animality of the *Closteria* by Mr. Dalrymple: this is the presence in each extremity of *Closterium* of a distinct organ or vesicle which contains a number of active and revolving molecules. But moving and revolving particles are met with in many undoubted *Algæ*, and, therefore, their presence in *Closterium* cannot be considered as decisive: moreover, no such organ presents itself in any other genus of *Desmideæ*, the proofs of the vegetability of which may be regarded as decisive, and to which the *Closteria* are too evidently related for the idea to be entertained that the one are animal and the other vegetable productions.

The *Desmideæ* are found in old boggy pools, the waters of which are not periodically dried up, but which are permanent for several years. They do not usually float on the surface, but are found in cloud-like masses near the bottom. They are best removed on pieces of linen, on which, if moistened regularly, they may be preserved unaltered for several days.

Section i.

Frond *filamentous.*

51. DESMIDIUM *Ag.*

Char. Frond *filamentous, simple, spirally twisted, fragile, articulated and angular;* mature *cells bipartite;* angles

mostly bicrenate. Endochrome *frequently bipartite, in the transverse view stellate, not filling entirely the cavity of the cells.* Reproduction *by bodies analogous to zoospores.*

Derivation. From δεσμος, *a bond.*

a. Filaments *with two angles.*

* Mucous sheath *very evident.*

1. DESMIDIUM CYLINDRICUM *Grev.*

Plate LXXXIII. Figs. 1, 2.

Char. Filaments *stout, somewhat compressed, with two bicrenate angles.* Crenatures *strongly marked.* Cells *rather longer than broad, connected by a thickened border, mucous* sheath *very evident.* Endochrome *four or five rayed.*

Grev. Scot. Crypt. Flor. t. 293.; Desmar, n. 1110.; Harv. in Manual, p. 196. *Didymoprium Grevillei* Kützing, Phyc. Gener. *Desmidium cylindricum* Ralfs, in Annals, vol. xi. p. 378. pl. viii. fig. 1.

Hab. Scotland: *Dr. Greville.* At the bottom of shallow pools and ditches, Appin: *Captain Carmichael.* In old peat pits about Dolgelly, North Wales; sparingly near Penzance: *Mr. Ralfs.* In a watercourse on Chiltington Common, near Pulborough, Sussex: *Mr. Jenner.* Cheshunt: *A. H. H.* In Caragh Lake, Kerry: *Mr. Andrews.* Bog holes, co. Meath: *Mr. Moore.*

The above description embraces all the essential characters of the species which may be regarded as the type of the genus. In consequence of the spiral twisting of the filaments the crenatures are much more perceptible in certain cells than in others; they are most strongly marked as a rule at about every tenth cell, gradually diminishing from these towards the central cells of the series, where they are much less apparent, and where the extremities of the crenatures, instead

of being pointed are truncate. This species, as well as indeed all the *Desmideæ*, are most beautiful microscopic objects. I do not see the necessity for instituting a new genus for its reception. I have not, therefore, adopted that of Kützing; viz. *Didymoprium.*

** Mucous sheath *not apparent.*

2. DESMIDIUM BORRERI *Ralfs.*

Plate LXXXIII. Figs. 9, 10.

Char. Filaments *slender.* Cells *biangular, inflated, elongated, being about twice as long as broad.* Endochrome *five or six rayed.*

Desmidium Borreri Ralfs, in Annals of Nat. Hist., vol. xi. p. 375. t. 8. p. 4. *Didymoprium Borreri* Jenner, in Fl. Tunbridge Wells, p. 192.

Hab. Boggy ditch at Crom Bychan: *Mr. Borrer.* Llyn y Cwyn: *Mr. Borrer* and *Mr. Ralfs.* In all peat bogs near the outlet of Llanberris Lakes and near Dolgelly, North Wales: *Mr. Ralfs.* On Ashdown Forest near Duddles Well; in the great bog near Forest Row, and at Chiltington Common, near Pulborough: *Mr. Jenner.* Bog holes, co. Meath: *Mr. Moore.*

This is one of the most graceful and easily recognised species of the genus, remarkable principally for the great length of the cells; the endochrome in each cell is distinctly divided into two masses, which arrangement imparts to the plant somewhat the appearance of a *Tyndaridea.*

The cells are somewhat inflated, and each resembles in form two flower-pots juxtaposed by their mouths; the rims being represented by the crenatures of the cells, between which passes circularly round each cell a superficial groove, in the situation of which the cells at an advanced period of their developement separate, and give issue to their granular contents. Viewed transversely, the cells are spherical, with slight lateral projections.

b. Filaments *triangular.*

* Mucous sheath *not apparent.*

3. DESMIDIUM SWARTZII *Ag.*

Plate LXXXIII. Figs. 7, 8.

Char. Filaments *triangular.* Cells *rather shorter than broad, bicrenate, angles of the cells well marked.* Endochrome *three-rayed.*

Grev. Scot. Flor. t. 292.; Ehren. Die Infus. p. 140. t. 10. f. 8.; Pritch. Infus. p. 183.; Harv. in Manual, p. 196.; Ag. Syst. p. 9.; Ralfs, in Annals of Nat. Hist. vol. xi. p. 375. plate viii. fig. 3.; Jenner, in loc. cit. p. 192.

Hab. Scotland: *Dr. Greville.* Appin: *Captain Carmichael.* Tunbridge Wells: *Mr. Borrer.* Swansea, South Wales; Caernarvon and Dolgelly, North Wales; Penzance: *Mr. Ralfs.* High Beech, Epping: *A. H. H.* Rusthall Common, and in a pond between Ramslye rocks and Broadwater Forest; Battle; Chiltington Common, near Pulborough: *Mr. Jenner.* Bog holes, co. Meath: *Mr. Moore.*

In consequence of the filaments of this species being triangular, the spiral twisting of the threads is more evident than in any other species of the genus. When the microscope is brought to bear upon any filament, two of the three lines of crenatures are visible, and the third is indicated by a dark waved line passing from one margin of the filament gradually towards the other, the dark appearance of the line being occasioned by the dense endochrome of the cells situated immediately behind the crenatures.

Kützing limits the genus *Desmidium* to this one species, which he considers to differ generically from the other species usually associated with that genus, in the fact of the presence of the third angle to the cells — a distinction not considered to to be sufficient in the case of the genus *Staurastrum* for the foundation of new genera. The German professor has

therefore been induced to institute a new genus for *D. cylindricum*, under the name of *Didymoprium*. This genus, in my humble opinion, ought not to be adopted; and if it be really a good and valid genus, then is there sufficient reason why *D. Borreri* should form the type of a genus different from both, for it differs from *D. Swartzii* in the cells being biangular and not triangular, and from *Desmidium cylindricum* Grev., the *Didymoprium Grevillei* of Kützing, in the absence of a mucous sheath. There would thus be as many genera as there were formerly considered to be species of *Desmidia*, a result not altogether satisfactory.

c. Filaments *with four angles.*

4. Desmidium quadrangulatum *Ralfs.*

Plate LXXXIV. Fig. 3.

Char. Filaments *quadrangular.* Endochrome *four-rayed.*

Ralfs, in Annals, vol. xv. p. 405. pl. xii. fig. 9.

Hab. In a boggy pool at Balogas, near Penzance: *Mr. Ralfs.*

Notwithstanding the strong resemblance which it bears to *Desmidium Swartzii*, this plant appears to me to be very distinct. In consequence of the filaments having four angles instead of three, and as they are spirally twisted in the same manner as those of other *Desmidia*, it follows, that two dark, and waved lines, describing two of the four angles, are visible in the length of the thread. The observation of these will at once serve to distinguish it from *Desmidium Swartzii*, of which Mr. Berkeley, Mr. Borrer, and Mr. Ralfs consider this plant to be a variety: the latter, however, remarks that he has gathered it for two successive years quite unmixed with that species.

It seems to me that this plant has not merely a right to be considered as specifically distinct from *D. Swartzii*, but nearly as much claim (a claim however which I do not allow) to be

regarded as generally distinct therefrom, as *D. cylindricum* and *D. Swartzii* have to be so considered.*

52. GLÆOPRIUM *Berk. MSS.*

Char. Filaments *cylindrical, invested in a broad elastic sheath.* Cells *slightly crenate.* Endochrome *stellate.*

From the above definition it would appear that this genus does not differ in any marked manner from *Desmidium* There is certainly more ground for its formation than for the establishment of Kützing's *Didymoprium;* but perhaps the ends of science and of nomenclature would have been answered to have placed the two species which it is made to comprise and which differ as widely from each other as they do almost from the genus *Desmidium* in a distinct section of that genus.

1. GLÆOPRIUM DISSILIENS *Berk.*

Plate LXXXIII. Figs. 3, 4.

Char. Filaments *fragile.* Cells *slightly crenate, grooved between the crenatures, nearly as long as broad.* Sheath *broad.* Endochrome *six or seven rayed.*

Desmidium mucosum Breb. *Conf. dissiliens,* Eng. Bot. t. 2464. *D. mucosum* Ralfs, in Annals, vol. xi. p. 374. plate viii. fig. 2. *Glœoprium dissiliens* Jenner, in Fl. Tunbridge Wells, p. 192.

Hab. Crom Byclan: *W. Borrer,* Esq. Tunbridge Wells and other places in Sussex, frequent: *Mr. Jenner.* Near Bedgelert and about Dolgelly, North Wales; Swansea, South Wales; plentiful near Penzance, Cornwall: *Mr. Ralfs.* High Beech, Essex; Hertford Heath and

* Mr. Jenner has pointed out a character which seems to set the question of the distinctness of this species at rest. He states that in *Desmidium quadrangulatum* the angles of the cells are rounded, while in *D. Swartzii* they are acute.

Wormley West End, Herts: *A. H. H.* Bandon: *Prof. G. J. Allman.* Co. Kerry: *Mr. Andrews.*

The filaments when viewed separately, or as regards the line of cells are rather slender, but when taken in connection with the broad sheaths, their diameter is considerable; this sheath, though expanded and firm, often, unless a good microscope be used, escapes detection. It is from the presence of this sheath that the plant owes its excessive mucosity, and it is by it that we account for the parallel arrangement which the filaments frequently assume on the field of the microscope, without at the same time appearing to touch each other, although they really do so by means of the almost invisible mucous sheath. The contrast between the coloured cells and the transparent sheath renders this an exceedingly beautiful microscopic object.

2. GLÆOPRIUM MUCOSUM *Berk.*

Plate LXXXIII. Figs. 5, 6.

Char. Filaments *not fragile.* Cells *usually nearly as long as broad, not grooved round the centre.* Angles *of cells mostly minutely bicrenate.* Sheath *very broad, faint.*

Conf. mucosa Mertens, Dillw. Syn. t. β; Harvey, in Hook. Br. Fl. p. 351.; also in Manual, p. 127. *Glæoprium mucosum* Jenner, in Flora of Tunbridge Wells. *Desmidium bimucronatum* Hassall, MSS.

Hab. In stagnant water, Bantry: *Miss Hutchins.* Appin: *Captain Carmichael.* Cheshunt Common, High Beech and elsewhere: *A. H. H.* Penzance: *Mr. Ralfs.* Bogs at Fisher's Castle, very abundant, Sept. 1844; Chiltington Common: *Mr. Jenner.*

This species differs very considerably from the previous one, in having somewhat longer cells, a more highly developed mucous sheath, in the absence of the central constriction of the cells, and in the presence of the excessively minute bicrenate processes placed at the angles of the cells, and which were

noticed by Mr. Ralfs and Mr. Jenner nearly simultaneously. The processes are not present at all the angles of every cell, but only at those angles which have been for the longest period formed: thus, when a cell has become but recently divided no processes are present on the newly formed angles which result from this division. Owing to the existence of the highly developed mucous sheath, the filaments are disposed often as in the previously described species parallelly.

Mucous sheath much broader than in *G. dissiliens*, but less perceptible.

53. SPHÆROZOSMA *Corda.*

Char. Filaments *very fragile, compressed, consisting of bipartite cells united by means of gland-like processes, and much constricted between each cell.*

This genus is distinguished from the previous genera by its compressed frond, and by the glandular processes at the junction of the cells.

1. SPHÆROZOSMA ELEGANS *Corda.*

Plate LXXXIV. Fig. 1.

Char. Cells *smooth, rather longer than broad, deeply divided on each side into two portions.* Glands *single, one in the centre of each margin.*

Sphærozosma elegans Corda, Almanac de Carlsbad, 1835, t. iv. f. 37. *Odontella? unidentata* Ehr., Infus. p. 159. *Desmidium compressum*, Annals of Nat. Hist. vol. ix. p. 253. *Schistochilum* Ralfs, *unidentatum* Jenner, in Fl. of Tunbridge Wells, p. 192. *Desmidium vertebratum* Breb. et Godey.

Hab. Chyan-hâl Moor, near Penzance; and Towednack Moor, near St. Ives: *Mr. Ralfs.* Rotherfield, and in Jack's Wood spring: *Mr. Jenner.*

For the figures of this and the following species I am indebted to Mr. Jenner.

2. SPHÆROZOSMA EXCAVATUM.

Plate LXXXIV. Fig. 2.

Char. Cells *longer than broad, excavated laterally, with two glands or teeth at each margin.*

Schistochilum excavatum Ralfs, MS.; Jenner, in Flora of Tunbridge Wells, p. 192.

Hab. In a boggy spot near Cross in Hand, opposite to where the road branches to Hailsham; bogs at Fisher's Castle, and in a pond between Ramslye and Broadwater Forest: *Mr. Jenner.*

A very distinct and interesting species.

Section ii.

Frond *not forming filaments.*

54. GONIOCYSTIS *Hass.*

Char. Cells *angular.*

Derivation. From γωνια, *an angle,* and κυστις, *a cell.*

Section i. *TRIGONOCYSTIS* Hass.

Char. Cells *with three angles.*

Derivation. From τριγωνον, *triangular,* and κυστις, *a cell.*

1. TRIGONOCYSTIS ORBICULARIS *Hass.*

Plate LXXXIV. Fig. 7.

Char. Frond *smooth, suborbicular.* End view *triangular.* Angles *obtuse.*

Staurastrum orbiculare Meneghini, Synop. Desmid. p. 225. *Desmidium orbiculare* Ehr., Infus. p. 141. tab. 10. fig. 9. *Staurastrum orbiculare* Ralfs, in Annals, vol. xv. p. 152. pl. x. fig. 4. a. b. c.; Jenner, in loc. cit. p. 192.

Hab. Jack's Wood spring; Cross in Hand, &c.: *Mr. Jenner.* Dolgelly and Penzance: *Mr. Ralfs.*

The fronds are rather large, smooth, deeply constricted in the centre; the segments, broader than long, are in close approximation with each other, and when taken together form an orbicular frond in their front view, in which aspect the species might be taken for a *Cosmarium*, from which genus it differs in the triangular transverse form of the segments.

T. orbicularis forms a distinct link between *Cosmarium* on the one side and *Desmidium* on the other. It is distinguished from the following species by its suborbicular frond and by its blunt angles being destitute of processes.

2. Trigonocystis mucronata *Hass.*

Plate LXXXIV. Fig. 8.

Char. Fronds *smooth, deeply constricted in the front view, segments either transversely elliptical or lunate.* End view *three-lobed.* Lobes *inflated, blunt, mucronate, a single mucro terminating each lobe.*

α In the front view the segments *are transversely elliptic and the* mucro *straight.*

β Segments, *in front view, transversely lunate, outer margin straight,* mucro *curved outwards.*

γ Segments, *in front view, transversely lunate, outer margin curved,* mucro *curved inwards.*

Staurastrum mucronatum Ralfs, in Annals, vol. xv. p. 152. pl. x. figs. 5, 6.; Jenner, in loc. cit. p. 192.

Hab. On Ashdown Forest; Piltdown Common; Fisher's Castle, and near Cross in Hand: *Mr. Jenner.* Dolgelly and Penzance: *Mr. Ralfs.*

This, although a variable species, would appear to be well characterised by the lobed form of the segments viewed endways and the presence of the spine-like teeth.

Mr. Ralfs and Mr. Jenner have observed the occurrence

and formation of sporangia in this species, resulting as in other *Desmideæ* from the union of the endochromes of two cells, which in them is never effused from one cell into another, but always into a distinct receptacle intermediate between the two fronds: this is also the case in certain species of *Tyndarideæ* and *Mesocarpi* amongst the *Conjugateæ*.

The sporangia in *T. mucronata* are circular and smooth, and at first enclosed in a membrane larger than itself, this gradually disappears, and the sporangium becomes spinous, in which state it bears some resemblance to a *Xanthidium*. I have observed occasionally the sporangia of the *Vesiculiferæ* to present an appearance exactly similar, a fact which has not escaped the attention of Mr. Thwaites.

3. TRIGONOCYSTIS MURICATA *Hass.*

Plate LXXXIV. Fig. 9, 10.

Char. Fronds *muricated, deeply constricted, transversely elliptic.* Segments *approximate.* End view *triangular, with convex sides.*

β Fronds *furnished with short spines.*

Meneghini, Synops. Desmid. p. 266. *Binatella muricata* Breb., Alg. Fal. p. 66. (1835). *Desmidium apiculosum* Ehr., Infus. p. 142.; Ralfs, in Annals, vol. xv. p. 154. pl. xi. fig. 1.; Jenner, in loc. cit. p. 194. — β. *Xanthidium deltoideum* Corda, Observ. Microscop. sur les Animalc. de Carlsbad, p. 29. pl. v. figs. 38, 39.

Hab. In small pools; Cheshunt: *A. H. H.* Weston Bogs, Hants; Rackham Common, near Pulborough; Piltdown Common, near Uckfield; Mayfield and Heathfield. Sussex: *Mr. Jenner.* Dolgelly and Penzance: *Mr. Ralfs.* — β. Sussex: *Mr. Jenner.* Dolgelly: *Mr. Ralfs.*

From *Staurastrum tricorne* this species may be at once distinguished by the convex sides of the segments in the end view, and by the adult fronds being not merely muricated but spinous. The variety is probably distinct.

4. Trigonocystis hexaceros *Hass.*

Plate LXXXIV. Fig. 11.

Char. Fronds *rough.* Segments *about twice as long as broad, separated from each other by a deep notch, twisted.* End view *triangular, with concave sides and blunt entire angles.*

S. tricorne Meneghini, Synopsis Desmid. p. 225. *Binatella tricornis* Breb., Alg. Fal. p. 57. (1835). *Desmidium hexaceros* Ehr., Abhand. der Akademie d. Wissensch. zu Berlin (1832), p. 292.; Ehr. Die Infus. p. 141. t. x. fig. 10. *Staurastrum tricorne* Ralfs, in Annals, vol. v. p. 155. pl. xi. fig. 2.; Jenner, in loc. cit. p. 194.

Hab. Shallow pools, Piltdown Common; Ashdown Forest; Rusthall Common; between Mayfield and Hadlow Down: *Mr. Jenner.* Barmouth: *Rev. T. Salwey.* Dolgelly and Penzance: *Mr. Ralfs.* High Beech: *A. H. H.*

"The conic granules arranged in transverse lines at the angles are generally very minute, but in some Sussex specimens gathered by Mr. Jenner they are large, and on the margin produce a dentate appearance."— *Ralfs.*

5. Trigonocystis gracilis *Hass.*

Plate LXXXV. Fig. 1.

Char. Fronds *muricated, deeply constricted in the centre, two or three times longer than broad, tapering on each side into a slender process, which is terminated by three minute teeth.* End view *triradiate.*

Euastrum No. 13. Bailey, in American Bacillaria, pl. i. fig. 2—5. *Staurastrum gracile* Ralfs, in Annals, vol. xv. pl. xi. fig. 3.

Hab. Boggy pools, Dolgelly, and Penzance: *Mr. Ralfs.*

Although but three processes or teeth usually present themselves to the observer, the real number is four; but this is only to be seen when one of the angles or rays is so situated that its extremity is directly presented to the observer.

6. TRIGONOCYSTIS? ACULEATA *Hass.*

Plate LXXXIV. Fig. 12.

Char. Fronds *spinous.* Segments *in the* front view, *with a process on each side terminating in three minute spines.* End view *triangular, with concave sides.*

β End view *quadrangular, with four distorted rays.*

Staurastrum aculeatum Menegh., Synops. Desmid. p. 226. *Desmidium aculeatum* Ehr., Infus. p. 142. t. 10. fig. 12.; Ralfs, in Annals, vol. xv. pl. xi. fig. 4.; Jenner, in loc. cit. p. 194.

Hab. Cross in Hand; Sussex, and Beckley Furnace: *Mr. Jenner.* Penzance: *Mr. Ralfs.* — β. Woking Common, Surrey, and Piltdown Common, Sussex: *Mr. Jenner.* Penzance: *Mr. Ralfs.*

The spines are larger and longer in this than in any other species of the genus. The *variety*, which I have not seen, would appear to be referrible to the species proper, and is therefore very interesting.*

Section ii. *STAURASTRUM* Ehr.

Char. End view *quadrangular, often four-rayed, rays of one segment diverging from those of the other.*

Derivation. From σταυρος, *a cross*, and αστρον, *a star.*

1. STAURASTRUM DILATATUM *Ehr.*

Plate LXXXV. Fig. 5.

Char. Frond *rough, deeply constricted in the centre.* Segments *twice as broad as long, obtuse at the sides, and not elongated into processes.* End view *quadrangular.* Angles *obtuse, sides excavated.*

Ehr. Die Infus. p. 143. t. 10. fig. 13.; Menegh. Synops.

* Is not the normal number of rays in this species *four*, and is it not therefore a *Staurastrum*?

Desmid. p. 227.; Ralfs, in Annals, vol. xv. pl. xi. fig. 5.; Jenner, in loc. cit. p. 194.

Hab. Rusthall Common, near Tunbridge Wells; and Rackham Common, near Pulborough, Sussex: *Mr. Jenner.* Dolgelly: *Mr. Ralfs.*

The angles in this species are not as in the others prolonged into rays, and this will at once serve to distinguish it from those species.

2. Staurastrum? tetracerum *Ralfs.*

Plate LXXXIV. Fig. 4.

Char. Frond *rough.* Segments *but slightly constricted, quadriform.* Outer angles *prolonged into diverging rays which are entire at their extremities.* End view *compressed, with a process at each extremity.*

Staurastrum paradoxum Ehr., Infus. p. 143. t. 10. fig. 14. *Micrasterias tricera* and *tetracera* Kütz., Synops. Desmid. in Linnæa, 1833, p. 602. figs. 83, 84, 85.; Ralfs, in Annals, vol. xv. pl. x. fig. 1.

Hab. Dolgelly and Penzance: *Mr. Ralfs.*

The minute granules with which the frond is covered form transverse lines on the rays, and give them a jointed appearance. This species, in its compressed ellipsoidal form in the end view, would appear to approach closely the genus *Arthrodesmus.*

3. Staurastrum paradoxum *Meyen.*

Plate LXXXV. Fig. 3.

Char. Fronds *rough, constricted.* Ends *truncate.* Front view *elongated, diverging processes minutely trifid.* End view *usually quadrangular, but sometimes triangular.*

Meyen, Nov. Act. Scap. Holm. vol. xiv. p. 43. figs. 37. 38.; Menegh. Synops. Desmid. p. 227. *Micrasterias Staurastrum* Kütz., in Linnæa, p. 399.; Ralfs, in Annals vol. xv. p. 151. pl. x. fig. 2.

Hab. Dolgelly and Penzance: *Mr. Ralfs.*

This *Staurastrum* is to be distinguished from the previous species by the trifid extremities of the rays.

4. STAURASTRUM ? BIFIDUM *Ralfs.*

Plate LXXXV. Fig. 2.

Char. Frond *smooth, but little constricted in the centre, truncate laterally.* Rays *trifid.* End view *triradiate.*

Desmidium bifidum Ehr., Die Infus. p. 141. t. 10. f. 11.; Ralfs, l. c. p. 151. pl. x. fig. 3.

Hab. Dolgelly and Penzance: *Mr. Ralfs.*

The smoothness of the frond will always distinguish this from the previous species. It should probably be referred to *Trigonocystis.*

Section iii. *PENTASTERIAS* Ehr.

Char. Frond *in* front view *without diverging processes.* End view *circular, with usually five rays.*

Derivation. From πεντε, *five,* and αστεριας, *starred.*

1. PENTASTERIAS ARACHNIS *Hass.*

Plate LXXXV. Fig. 8.

Char. Frond *rough, deeply constricted in the centre.* Segments *about as long as broad, suborbicular, with elongated slender hyaline and incurved processes.* End view *five-rayed.*

Staurastrum Arachne Ralfs, in Annals, vol. xv. p. 157. pl. xi. fig. 6.

Hab. Boggy pool near Dolgelly, very rare: *Mr. Ralfs.*

" This plant is remarkable for its slender processes which will easily distinguish it from *St. margaritaceum.* It cannot be a five-rayed variety of *St. gracile,* for the rays are longer, more slender, remarkably incurved, and also entire at the extremity." — *Ralfs.*

2. Pentasterias margaritacea *Ehr.*

Plate LXXXV. Fig 7.

Char. Frond *rough.* Segments *in* front view *subglobose, attenuated at their junction, with short lateral converging processes which are entire at their apices.* End view *with five, rarely six or seven, short obtuse rays.*

Staurastrum margaritaceum Menegh., Synops. Desmid. p. 227.; Ralfs, in Annals, vol. xv. p. 157. pl. xi. fig. 7. *Pentasterias margaritacea* Ehr., Infus. p. 144. t. 10. fig. 15.; Jenner, in loc. cit. p. 194.

Hab. Dolgelly: *Mr. Ralfs.* Ashdown Forest, Sussex: *Mr. Jenner.*

The rays are much stouter and shorter in this than in the preceding species.

3. Pentasterias Jenneri *Hass.*

Plate LXXXV. Fig. 6.

Char. Fronds *large, dentated.* Segments *about as broad as long, lengthened into a toothed angle on each side.* End view *with five, sometimes six, broad short-toothed rays.*

Staurastrum Jenneri Ralfs, in Annals, vol. xv. p. 158. pl. xi. fig. 8.; Jenner, in loc. cit.

Hab. Mayfield, Sussex: *Mr. Jenner.*

A very fine species. "The transverse view has a large central opening surrounded by a row of large granules."—*Ralfs.*

55. ARTHRODESMUS *Ehr.*

Char. Fronds *smooth, deeply constricted.* End view *compressed, angles prolonged into a spine.*

Derivation. From ἀρθρον, *a joint,* and δεσμος, *a link.*

The stout spines terminating the angles of the segments seem to connect this genus with *Xanthidium.*

1. Arthrodesmus convergens *Ehr.*

Plate LXXXV. Fig. 9.

Char. Segments *broader than long, somewhat elliptic, elongated at each side into an incurved spine.* End view *compressed, with a spine at each extremity.*

Arthrodesmus convergens Ehr., Infus. p. 152. t. 10. fig. 18. *Staurastrum convergens* Menegh., Synops. Desmid. p. 228.; Ralfs, in Annals, vol. xv. p. 158. pl. xii. fig. 1.; Bailey, Amer. Bacil. pl. i. fig. 11.; Jenner, in loc. cit. p. 194.

Hab. Brambletye, near East Grinstead; Rackham Common, near Pulborough, Sussex; and Rusthall Common, near Tunbridge Wells: *Mr. Jenner.* Dolgelly and Penzance: *Mr. Ralfs.* Cheshunt: *A. H. H.*

The incurved mucrones will at once serve to distinguish this species.

2. Arthrodesmus Incus *Hass.*

Plate LXXXV. Fig. 10.

Char. Segments *externally lunate, with a mucro at each angle.* End view *elliptic, mucronated at each extremity.*

Euastrum Bailey, Amer. Bacil. pl. i. fig. 12.? *Staurastrum Incus* Meneghini, Synops. Desmid. p. 228.; Ralfs, in Annals, vol. xv. p. 159. pl. xii. fig. 2.; Jenner, p. 194.

Hab. Weston Bogs, near Southampton; Rackham Common, near Pulborough, Sussex: *Mr. Jenner.* Dolgelly and Penzance: *Mr. Ralfs.*

The mucro in this species is turned outwards: in the front view the segments resemble those of *Trigonocystis mucronata,* but the end view is very different.

3. Arthrodesmus octocornis *Ehr.*

Plate LXXXV. Fig. 11.

Char. Fronds *compressed.* Segments *broader than long,*

quadrangular, each angle produced into a spine. End view *subelliptic, with a spine at each extremity.*

Arthrodesmus octocornis Ehr., Infus. p. 152. *S.? octocorne* Ralfs, in Annals, vol. xv. p. 159. pl. xii. fig. 3.

Hab. Boggy ponds near Dolgelly, rare: *Mr. Ralfs.*

"The newly formed segments at first have only two spines, and in this state somewhat resemble those of *Staurastrum Incus*, of which indeed this plant may eventually prove a variety. But *S. Incus* has only two spines on each segment, and its end is not concave but truncate." — *Ralfs.*

The *Micrasterias octocornis* of Meneghini would appear to be a different plant.

56. XANTHIDIUM *Ehr.*

Char. Frond *composed of two slightly compressed segments constricted in the centre, neither lobed, sinuated, nor emarginate.* Surface *clothed with simple or branched elongated spines, either scattered or confined to the margin, where they are apparently placed in two rows, one on each side the marginal lines.* Segments *anteriorly perforated in the centre* (*?*).

Derivation. From *ξανθος, yellow?*

This genus bears a close resemblance to *Cosmarium*, from which there is no satisfactory character to distinguish it, unless indeed the projection or aperture noticed to occur by Mr. Dalrymple in *Xanthidium furcatum*, and by Mr. Ralfs in *X. aculeatum* be constant in all the true species of the genus *Xanthidium*. Meneghini even goes so far in the union of the genera *Xanthidium* and *Cosmarium*, as to retain in the former genus only those species whose spines are scattered over the surface, while he refers to the latter genus those in which the spines are confined to the margin. This arrangement seems arbitrary; and that it is so, is proved by the fact that in a species of *Xanthidium* figured by Dr. Bailey in the "American Bacillaria," and which has six pairs of *marginal*

spines, the central apertures exist; that is, in the species referred by Meneghini to *Cosmarium* these openings are met with — the only character which is even supposed to belong exclusively to *Xanthidium*.

"I have little doubt that there are more British species of *Xanthidium* than I shall here describe, and indeed believe that I have more than once gathered *X. hirsutum*; but as my attention was not directed to the *Desmidcæ* at the time, I neglected to examine it with sufficient care to be able to state my observations with any confidence in this paper." — *Ralfs*.

1. Xanthidium furcatum *Ehr.*

Plate LXXXIX. Fig. 1.

Char. Segments *reniform.* Spines *at first marginal, subsequently scattered, dividing at their terminations into three or four acute divergent points.*

Xanthidium furcatum Ehr., Infus. p. 148. tab. x. f. xxv.; Menegh. Synops. Desmid. p. 224. *Xanthidium* No. 2., Bailey's American Bacillaria, p. 291. pl. i. fig. 15.; Ralfs, in Annals, vol. xiv. p. 466. pl. xii. fig. 1.

Hab. Several places in Sussex: *Mr. Jenner.* Dolgelly, and near Carmarthen: *Mr. Ralfs.* High Beech and Cheshunt Common: *A. H. H.* Aberdeen: *Dr. Dickie.* Ireland: *Mr. Moore.*

This is the finest as well as commonest species of the genus. There is no other with which it can be confounded.

In the figure of this species, given by Ehrenberg, the central aperture seems to be indicated.

2. Xanthidium fasciculatum *Ehr.*

Plate LXXXIX. Fig. 2.

Char. Segments *small, reniform.* Spines *in pairs, and usually six pairs to each segment.*

Xanthidium aculeatum, Abhandl. d. Akademie d. Wissensch.

zu Berlin, 1833, p. 318. *X. fasciculatum* Ehr., Infus. p. 147. tab. x. fig. xxiv. b. *Xanthidium fasciculatum* Ralfs, in Annals, vol. xiv. p. 166. fig. 3. c. d. e. *Cosmarium aculeatum* Menegh., l. c. p. 218. *Euastrum* No. 10., Bailey's Amer. Bacil. p. 296. pl. i. fig. 10.; Jenner, in loc. cit. p. 194.

This species is smaller than the following, the segments of a different form, and the spines more numerous.

3. Xanthidium polygonum *Hass.*

Plate LXXXIX. Fig. 4.

Char. Frond *polygonal.* Segments *four-angled.* Spines *eight to each segment, in pairs, situated at the angles.*

Xanthidium fasciculatum β polygonum Ehr., Infus. p. 148. t. 10. fig. 24. a. *Xanthidium fasciculatum β polygonum* Ralfs, in Annals, vol. xiv. p. 467. pl. xii. fig. 3. a. b.

Hab. Near Dolgelly: *Mr. Ralfs.* Near Tunbridge Wells: *Mr. Jenner.*

This doubtless ought not to be regarded as a variety, but as a distinct species, differing from *Xanthidium fasciculatum*, of which it has hitherto been regarded as a variety, in being altogether a much larger plant, in the polygonal form of the segments, and in the number of the spines to each segment, which are eight in *X. polygonum*, arranged in four pairs, while in *X. fasciculatum* they are twelve, disposed in six pairs.

4. Xanthidium aculeatum *Ehr.*

Plate LXXXIX. Fig. 3.

Char. Segments *reniform, almost globose.* Spines *single, marginal, and scattered.*

Xanthidium aculeatum Ehr., Infus. p. 147. tab. 10. fig. 23.; Menegh. l. c. p. 224.; Ralfs, in Annals, vol. xiv. p. 467. pl. xii. fig. 2. a. b. c. d.

Hab. Ashdown Forest, and near Cross in Hand: *Mr. Jenner.* Penzance: *Mr. Ralfs.*

This species differs from *X. fasciculatum* principally in the spines being single and not in pairs as in that species.

"In the centre of each segment, on both surfaces, is a projection similar to that described under *X. furcatum*, but less evidently dentated." — *Ralfs.*

57. CYLINDROCYSTIS *Menegh.*

Char. Frond *mucous, indefinite.* Corpuscles *cylindrical, filled with sporidia, copulating, at length bearing two spores transversely divided into halves.*

Derivation. From κυλινδρος, *a cylinder*, and κυστις, *a cell.*

1. Cylindrocystis Brebissoni *Menegh.*

Plate XCII. Fig. 17.

Char. Cells *cylindrical, two or three times longer than broad, with rounded extremities.*

C. Brebissoni Menegh., Monog. Nostoc. Italic.

Hab. Sussex: *Mr. Jenner.* High Beech: *A. H. H.* Aberdeen: *Dr. Dickie.* Galway: *M'Colla.*

This is a particularly interesting production, as it seems to form a direct link between the *Protococcoideæ* and the *Desmideæ*, and by Meneghini himself is placed in the family *Nostochineæ*. The conjunction of the cells, as well as their great size and regular form, have induced me to refer it to the *Desmideæ*, in which the phenomenon of union of the cells is of such frequent occurrence. The frond does not appear to be divided in the centre as in most true *Desmideæ*.

58. COSMARIUM *Corda.*

Char. Frond *constricted in the middle.* Segments *frequently as broad and sometimes broader than long, neither*

notched nor lobed, but mostly either denticulated or dotted, almost touching each other.

Derivation. From *κοσμαριον, a small ornament.*

The form of the frond in this genus is much more simple than that of most of the other genera of *Desmideæ*, being neither notched nor lobed. The genus to which it is most closely allied is *Xanthidium*, from which it chiefly differs in the minuteness of the spines or teeth, which are placed on the outer surface of the frond in most species, as well as in the absence of the lateral apertures noticed in *Xanthidium furcatum* and *X. aculeatum*. Through *Closterium cylindricum*, it exhibits some relation to the genus *Closterium*, in which the form of the frond is also very simple; but the two genera are abundantly distinct. In *Cosmarium* the fronds are never elongated nor curved as in *Closterium*, and they are always constricted in the centre; neither are they notched as in *Tetmemorus* and *Euastrum*, nor lobed as in the latter genus, nor compressed as in *Micrasterias*.

The denticulations observed on the surface of the fronds of most species of the genus vary according to the age of the specimens, being most strongly marked on the more fully developed examples.

a. Fronds *denticulated.*

1. COSMARIUM MARGARITIFERUM *Menegh.*

Plate LXXXVI. Fig. 1.

Char. Fronds *denticulated.* Segments *broader than long, somewhat hemispherical or reniform, compressed.* End view *elliptic.*

β Fronds *dotted, but not denticulated.*

Menegh. Synop. Desmid. in Linnæa, 1840, p. 219. *Cosmarium dentiferum* Corda, Observ. Microscop. sur les Animalc. de Carlsbad, p. 30. pl. vi. f. 41. *Euastrum margaritiferum* Ehr., Infus. p. 163. tab. 12. f. 7.; Pritch.

Infus. p. 196. f. 126.; Bailey, Amer. Bacil. in Am. Journ. of Sciences and Arts, vol. xli. No. 2. p. 295. fig. 8. *Ursinella margaritifera* Turp., Dict. des Sc. Nat. (1820). *Heterocarpella Ursinella* Kütz., Syn. Diatom. p. 598. *Cymbella reniformis* Ag., Consp. Diatom. p. 10.; Grev. in Hook. Br. Flor. vol. ii. p. 415.; Harv. Brit. Alg. p. 215. *Cosmarium margaritiferum* Ralfs, in Annals of Nat. Hist. vol. xiv. p. 393. pl. xi. fig. 4.; Jenner, in loc. cit. p. 194.

Hab. In bogs and pools, &c. common; Weston bogs, near Southampton, and numerous habitats in Sussex and Kent: *Mr. Jenner.* Farnham, Surrey: *Mr. Reeves.* Cheshunt, Herts: *A. H. H.* Near Bristol: *Mr. Thwaites.* Barmouth: *Rev. T. Salwey.* Dolgelly, Carnarvon, and Penzance: *Mr. Ralfs.*

This species varies considerably in size, form, and in the number and degree of developement of the spines, which cover the frond. Each segment may be compared in form to a kidney. It is the most abundant species of the genus. Ehrenberg figures the denticles as placed in regular series or rows, which in some specimens I have seen to be the case.

2. Cosmarium Botrytis *Menegh.*

Plate LXXXVI. Fig. 2.

Char. Frond *denticulated, compressed.* Segments *truncato-triangular.* End view *elliptic.*

C. Botrytis Meneg., Synop. Desmid. p. 220. *Euastrum Botrytis* Ehr., Infus. p. 163. tab. xii. fig. 8. *C. Botrytis* Ralfs, in Annals of Nat. Hist., vol. xiv. pl. xi. fig. 5. *Heterocarpella Botrytis* Bory, in Dict. Classique, 1825. *Euastrum angulosum* Ehr., Infus. tab. xii. fig. 8. *Cosmarium deltoides,* in part, Corda, Almanac. de Carlsbad, 1835, p. 205.

Hab. Near Bristol: *Mr. Thwaites.* Sussex: *Mr. Jenner.*

Near Manchester: *Mr. Sidebotham.* Dolgelly: *Mr. Ralfs.* High Beech: *A. H. H.*

A very distinct species. The frond is usually about a third less than that of *Cosmarium margaritiferum.*

3. Cosmarium ornatum *Ralfs.*

Plate LXXXVI. Fig. 3.

Char. Frond *denticulated.* Segments *broader than long.* Front view *curved at the sides, but truncate at the extremities.* End view, *four-lobed.*

Cosmarium ornatum Ralfs, in Annals, vol. xiv. p. 392. pl. xi. fig. 3.; Jenner, in Fl. of Tunbridge Wells, p. 194.

Hab. In boggy pools about Dolgelly and Barmouth: *Mr. Ralfs.* Ashdown Forest, Sussex: *Mr. Jenner.* Cheshunt Common: *A. H. H.*

This species is likewise very distinct, and there can be no danger of confounding it with any other hitherto described. The fronds are about as large as those of *C. margaritiferum,* the four-lobed form of the segment when viewed endways is peculiar to the species; this form is occasioned by the central inflation of each segment.

4. Cosmarium orbiculatum *Ralfs.*

Plate LXXXVI. Fig. 5.

Char. Segments *minute, nearly spherical, both in front and end views.*

Cosmarium orbiculatum Ralfs, in Annals, vol. xiv. p. 392. pl. xi. fig. 2.

Hab. Boggy pools, near Dolgelly: *Mr. Ralfs.* Near Manchester: *Mr. Sidebotham.*

A distinct little species, and the smallest of the genus.

5. Cosmarium cylindricum *Ralfs.*

Plate LXXXVI. Fig. 4.

Char. Fronds *small, finely denticulate.* Segments *longer than broad, in the front view, subquadrate, broadest at the extremity, narrower at their junction.* End view *circular.*

Cosmarium cylindricum Ralfs, in Annals, vol. xiv. pl. xi. f. 1.

Hab. Mixed with other *Algæ* on the wet sides of a cave at Laurarna Cove near Penzance: *Mr. Ralfs.*

The fronds are minute, and about twice as long as broad. Segments united along their entire breadth, so that no notches are formed at the sides.

b. Fronds *mostly punctated or smooth.*

6. Cosmarium crenatum *Ralfs.*

Plate LXXXVI. Fig. 6.

Char. Fronds *punctated.* Segments *broader than long, compressed, somewhat triangular, with the margins deeply crenated.* End view *elliptic.*

C. crenatum Ralfs, in Annals, vol. xiv. pl. xi. fig. 6.; Jenner, loc. cit. p. 196.

Hab. Weston bogs, near Southampton, and several stations in Sussex: *Mr. Jenner.* Near Bristol: *Mr. Thwaites.* Near Manchester: *Mr. Sidebotham.* Dolgelly and Penzance: *Mr. Ralfs.*

"This plant very much resembles a young specimen of *C. margaritiferum*; but as the margin is always strongly crenated, even in the earliest stage, and the surface is punctated and not granulated, I am induced to describe it as distinct." — *Ralfs.*

7. Cosmarium ovale *Ralfs.*

Plate LXXXVI. Figs. 8. and 9.

Char. Fronds *large, compressed, punctated.* Segments *triangular, slightly truncate at the extremity.* End view *broadly elliptic.*

β Segments *dentated.*

Cosmarium ovale Ralfs, in Annals, vol. xiv. pl. xi. fig. 7. — β. *Euastrum* No. 6. Bailey, l. c. p. 295. fig. 28.; Jenner, in loc. cit. p. 196.

Hab. Dolgelly: *Mr. Ralfs.* Barmouth: *Rev. T. Salwey.* Near Tunbridge Wells, in a pond between Ramlye and Broadwater Forest; Beckley Furnace: *Mr. Jenner.* — β. Weston bogs, near Southampton: *Mr. Jenner.*

The characters of the different species of *Desmideæ* may generally be so accurately embodied in the definition as to preclude the necessity of any lengthened remarks attached to each species; this conciseness it is to be hoped as our knowledge of the works of creation becomes more extensive, will be found applicable to the description of all organised productions.

8. Cosmarium Cucumis *Corda.*

Plate LXXXVI. Fig. 10.

Char. Fronds *orbicular, much compressed.* Segments *hemispherical, quite smooth, being neither denticulated nor dotted.* End view *elliptico-lanceolate.*

Meneghini, Synops. Desmid. p. 220. *Euastrum integerrimum* Ehr., Infus. p. 163. tab. 12. fig. 9. *Cosmarium Cucumis* Corda, Almanac de Carlsbad, 1835, p. 206. tab. 11. figs. 27, 28. *C. Cucumis* Ralfs, l. c. p. 395. pl. xi. fig. 8.; Jenner, in loc. cit. p. 196.

Hab. Sussex: *Mr. Jenner.* Dolgelly: *Mr. Ralfs.*

The frond is more orbicular and not punctated as in *Cosmarium ovale.*

9. Cosmarium quadratum *Ralfs.*

Plate LXXXVI. Figs. 11. and 12.

Char. Fronds *about twice as long as broad.* Segments *quadrate, in* front view *slightly compressed, smooth.*

Ralfs, l. c. vol. xiv. t. 11. f. 8.; Jenner, l. c. p. 196.

Hab. Rusthall Common, near Tunbridge Wells: *Mr. Jenner.* Dolgelly: *Mr. Ralfs.*

The front view of the segments is somewhat quadrangular, the distal or free angles being slightly rounded, and the proximate, protuberant.

10. Cosmarium Cucurbita *Breb.*

Plate LXXXVI. Fig. 7.

Char. Fronds *small, about twice as long as broad, cylindrical, with a slight constriction in the centre, minutely punctated.* End view *circular.*

Ralfs, in Annals, vol. xiv.; Jenner, in Flora of Tunbridge Wells, p. 196. *Cosmarium Cucurbita* Desm., No. 1103.

Hab. Dolgelly: *Mr. Ralfs.* Ashdown Forest and Greatham bogs, near Pulborough: *Mr. Jenner.*

This species approaches rather closely to *Cosmarium cylindrum* Ralfs, but the frond in that species is distinctly dentated, whereas in *C. Cucurbita* Breb. it is merely dotted: it also has a great resemblance to *Closterium cylindrus*, but in that plant the puncta are described as arranged in longitudinal lines, whereas in *Cosmarium Cucurbita* they are scattered.

59. CLOSTERIUM *Nitzsch.*

Char. Fronds *elongated, mostly crescentic, sometimes conjugating; each formed of two similar segments, which unite without constriction, and the free extremity of each*

of which is occupied by a vesicle *filled with active molecules.*

Derivation. From κλωστηρ, *a fine thread;* in allusion to the attenuated form of the frond.

The two peculiarities which distinguish the genus *Closterium* from all other *Desmideæ* are the crescentic form of the fronds and the presence in the free extremity of each of the segments, of the vesicle filled with revolving particles. These particles occasionally escape from the vesicle, and circulate vaguely and irregularly round the circumference of the frond. The use of these particles is not determined: it may be conjectured that they are in some way or other connected with reproduction.

The existence of motive papillæ or processes issuing from the open extremities of the segments has been denied by most recent observers.

Conjugation has been noticed to occur by Ehrenberg in *Closterium Dianæ, Cl. lineatum, Cl. striolatum,* and *Cl. inæquale.*

Ehrenberg, by whom the genus *Closterium* is placed amongst the polygastric animalcula, thus defines it:—

"Animalia polygastrica anentera (tubo intestinali destituta) gymnica (non appendiculata), et corpore uniformi involucrato seu loricato, cryptomonadibus simillima, cum lorica sponte et imperfecte dividua, hinc in polyparium bacilliforme (aut fusiforme) abeuntia, papillis denique in loricæ apertura discretis."

Independently of the irregular motion of the particles escaped from the cells, a circulation has been noticed, consisting of two opposite currents, the one along the side of the shell, and the other along the periphery of the internal gelatinous matter, which is invested with an elastic envelope.

By some systematists the *Closteria* are placed next to the *Conjugateæ,* with which in the occasional conjugation of the fronds of two *Closteria* and formation of sporangia they do indeed exhibit a certain degree of relationship.

Through *Closterium cylindrus* Ehr., Infus. pl. v. fig. 6. this genus would appear to be united to the genus *Cosma-*

rium: it is most probable, however, that that species ought to be referred to the latter genus.

a. Closteria *curved, smooth, not appendaged.*

1. Closterium Ehrenbergii *Menegh.*

Plate LXXXVII. Fig. 1.

Char. Frond *semilunar, thinned, and rounded at the extremities.* Granules *scattered.* Endochrome *fasciated.* Bands *two or three in each segment.*

Der halbe Mond, Eichorn, Kleinste Wassenthiere, p. 48. taf. 5. fig. c. 1775, 1781, 1784. *Vibrio Lunula* Müller, Naturforscher, 20. p. 142. 1784.; Herman (after Müller) ebenda, p. 169. taf. 3. fig. 59. *V. Lunula* Müller, Animalc. Infus. p. 55. taf. vii. figs. 13. and 15. 1717? *Mülleria? Lunula* Leclerc, 1802? *Conferve inédite,* No. 77. (*Zygnema deciminum*) Gerod Chantrans, Recherche sur les Conferves, t. 33. 1802. *Mülleria Lunula* Schrank, Fauna boica, iii. 2. p. 47. 1803. *Closterium Lunula* Nitzsch, Beiträge, ζ Infusarienkunde, 60. and 67. 1817? *Vibrio Lunula* Gruithuisen, Acta Nat. Curios. x. 2. p. 449. 1821. cfr. *Cl. moniliferum. Bacillaria Lunula,* Acta Nat. Curios. xi. 2. p. 533. 1823. *Lunulina vulgaris* Bory, Encyc. Méthod. 1824, and in Dict. Class. d'Hist. Nat. 1826. *Lunulina vulgaris* Turpin, Dict. d'Hist. Nat. Planches Végétaux, i. p. 3. 1828. *Closterium Lunula* Hemprich et Ehrenberg, Symbolæ Physicæ, Evertebrat. i. Phytozoa, tab. ii. iv. fig. 6. 1828. *Closterium Lunula,* Isis, 1830, p. 168. *Closterium Lunula,* Abhandl. der Academie d. Wissensch. zu Berlin, 1829, p. 7. 15. 1830, p. 40. 56. 62., 1831, p. 67. *Closterium Lunula,* Symbolæ Physicæ, text 1830 (1831), fol. b. a. 2. *Closterium Lunula* Kütz., Algæ Aquat. siccatæ, dec. iii. No. 22. 1833, and Synopsis Diatomearum, Linnæa, 1833, p. 596. *Closterium Lunula* and *acuminatum* Corda, Almanac de Carlsbad, 1835, p. 190. tafel 5. f. 56—60.

Closterium Lunula, Annales des Sciences Naturelles, 1836, tom. v. Botanique, p. 263. tafel ix. x. a, xi.; Jenner, in Flora Tonbridgensis, p. 196. *Cl. Ehrenbergii* Menegh., Synops. Desmid. *Cl. Lunula* Ehr., Die Infus. t. v. f. 2.

Hab. Several places in Sussex: *Mr. Jenner.* Cheshunt: *A. H. H.*

This species might readily be confounded with the next, *Cl. moniliferum,* in which the reproductive granules are in a single series, and not scattered as in *Cl. Ehrenbergii.*

The synonyms given require revision, on account of Ehrenberg having confounded two species.

2. Closterium moniliferum *Ehr.*

Plate LXXXVII. Fig. 2.

Char. Frond *much curved.* Apices *thinned and rounded.* Granules *disposed down the middle in a single series.* Endochrome *fasciated.* Bands *two or three.*

Vibrio Lunula var. Müller, Animalc. Infus. p. 55. taf. 7. fig. 8. 11. 1786. *P. planzenthier* Gruithuisen, Beitr. ζ Physiognosie *a* Eautognosie, p. 322. t. ii. fig. 40. *Closterium Lunula* Nitzsch, after Kützing, 1817. *Lunulina monilifera* Bory, Encyclopéd. Méthod. 1824; Dict. Classique d'Hist. Nat. 1826. *Lunulina vulgaris* Turpin, Dict. des Sciences Naturelles, Planches Végétaux, i. F. 3. a. rechts, 1828. *Closterium Lunula var.,* Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 68. *Closterium lunula* Kützing, Synopsis Diatomearum, Bot. Zeitsch. Linnæa, v. Schlechtendal, p. 596. t. xviii. fig. 80. 1833. *Closterium Lunula var.* Morren? Annales des Sc. Nat. Botanique, tom. v. p. 337. planche xi. fig. 42.; Jenner, in Flora of Tunbridge Wells, p. 196. *Cl. Leiblinii* Menegh., loc. cit.

Hab. Framfield, Hillingly, Reigate, &c.: *Mr. Jenner.* Cheshunt Common: *A. H. H.*

This species comes near to *Closterium Dianæ* Ehr., which, however, is a more elongated and more slender plant.

3. Closterium Dianæ *Ehr.*

Plate LXXXIV. Fig. 5.

Char. Frond *slender, much attenuated towards each end.* Granules *in a single series down the centre.* Endochrome *fasciated.* Fasciæ *obscure.*

Cl. ruficeps, Abhandl. der Akademie d. Wissench. zu Berlin, 1831, p. 67. *Cl. Dianæ* Ehr., Die Infus. p. 92. t. v. f. 17.

Hab. Chiltington Common, near Pulborough: *Mr. Jenner.*

A distinct and elegant species.

b. Closteria *curved, not appendaged, striated.*

4. Closterium turgidum *Ehr.*

Plate LXXXVII. Fig. 3.

Char. Frond *large, slightly curved, subcylindrical, but little attenuated, very finely striated.* Apices *roundish and rubescent.*

Closterium turgidum Ehr., Infus. tafel vi. fig. 7.; Jenner, in Flora of Tunbridge Wells, p. 196.

Hab. Several places in Sussex: *Mr. Jenner.*

The striæ in this species are finer, and the frond larger than in *Closterium striolatum.*

5. Closterium striolatum *Ehr.*

Plate LXXXVII. Fig. 4.

Char. Frond *fusiform, gradually attenuated towards each end, evidently striated, ten or twelve times as long as broad.* Extremities *rounded.*

Closterium striolatum, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 68.; 1833, p. 238. *Closterium costatum!* and *Cl. spirale* Corda, Almanac de Carlsbad, 1835, p. 191. taf. v. f. 61—63. and fig. 67.?; Ehr. Infus. p. 96. taf. 6. fig. 12.; Jenner, l. c. p. 196.

Hab. Several places in Sussex and Kent: *Mr. Jenner.* Hertford Heath: *A. H. H.* Aberdeen: *Dr. Dickie.* Galway: *M'Colla.*

This is a smaller species, more attenuated at the extremities, and with striæ more evident than in *Closterium turgidum.* Each segment is occasionally divided by a transverse line, as is well represented in one of the figures given by Ehrenberg.

6. Closterium lineatum *Ehr.*

Plate LXXXVIII. Fig. 1.

Char. Frond *very long, slender, slightly curved, in the centre cylindrical and filiform, much attenuated at each extremity, distinctly striated, often twenty times as long as broad.*

Closterium lineatum, Abhandl. der Akademie d. Wissensch. zu Berlin, 1833 (1832), p. 238.; Ehr. Infus. p. 96. t. 6. fig. 8.; Jenner, in Flora of Tunbridge Wells, p. 196.

Hab. Ashdown Forest: *Mr. Jenner.*

This is one of the most striking species of the genus; the granules are often arranged in single series, but sometimes they are scattered.

7. Closterium Cornu *Ehr.*

Plate LXXXVIII. Fig. 2.

Char. Frond *small, very slender, subcylindrical, slightly curved.* Endochrome *undulated.*

Vibrio Lunula Müller, Animalc. Infus. tab. vii. fig. 8.? *Closterium Cornu,* Abhandl. der Akademie d. Wissensch.

zu Berlin, 1830, p. 62.; 1831, p. 67. *Closterium tenue* Kützing, Synopsis Diatom. in v. Schlechtendal's Linnæa, p. 595. tafel xviii. f. 78.; Ehr. Infus. p. 94. taf. vi. fig. 5.; Jenner, in Flora of Tunbridge Wells, p. 196.

Hab. Piltdown Common: *Mr. Jenner.*

Apparently a very distinct little species.

c. Closteria *appendaged, curved, striated.*

8. CLOSTERIUM ROSTRATUM *Ehr.*

Plate LXXXVII. Fig. 6.

Char. Closterium *fusiform, slender, slightly curved, striated, much attenuated, appendaged, each horn scarcely equalling the body in length, often much shorter.*

Closterium rostratum, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 67.; 1833, p. 240. *Frustulia subtilis* and *subulata* Kützing? Synops. Desmid. p. 538. taf. xiii. fig. 3., 1833. *Closterium caudatum* Corda, Almanac de Carlsbad, p. 190. 209. tafel v. fig. 66., 1835; Jenner, l. c. p. 196.

Hab. Heathfield; Warbleton; Waterdown Forest, &c.: *Mr. Jenner.* High Beech: *A. H. H.*

A singular but not uncommon species.

9. CLOSTERIUM SETACEUM *Ehr.*

Plate LXXXVII. Fig. 7.

Char. Frond *fusiform, setaceous, straight, or very slightly curved, faintly striated, appendaged, appendages longer than the frond itself.*

Closterium setaceum, Abhandl. der Akad. d. Wissensch. zu Berlin, 1833, p. 239.; Jenner, in loc. cit. p. 196.

Hab. Waterdown Forest, and near Cross in Hand: *Mr. Jenner.* Cheshunt Common: *A. H. H.*

This species differs from the previous one in being much smaller, more finely striated, and having longer setaceous appendages.

d. Closteria *smooth, not appendaged, straight.*

10. Closterium Lunula *Ehr.*

Plate LXXXIV. Fig. 4.

Char. Frond *fusiform, ventricose, with rounded extremities.* Granules *numerous, scattered.* Endochrome *fasciated, bands usually three.*

Cl. Lunula Ehr., Die Infus. t. v. figs. 1. and 3. *C. Lunula* Menegh., Synops. Desmid.

Hab. Beckley Furnace: *Mr. Jenner.* High Beech: *A. H. H.*

This species I noticed when examining some *Pediastra* kindly sent me by Mr. Jenner. It is figured by Ehrenberg as a state of *Closterium Lunula,* and indeed Meneghini regards it as that species, conferring the name of Ehrenberg upon what better agrees with the name of *Lunula,* and with Ehrenberg's description, although this last is evidently so contrived as to embrace both species. The frond, in Mr. Jenner's specimens, was not of the gigantic size figured by Ehrenberg.

11. Closterium acerosum *Ehr.*

Plate LXXXVII. Fig. 5.

Char. Closterium *fusiform, gradually attenuated towards each extremity.* Granules *in a single series down the centre of the frond.* Endochrome *banded.*

Corpicetti a baccillo Corti? Observaz. Micros. p. 111. t. 11. fig. 17. i. g. and r.-s., 1774. *Vibrio Lunula* Müller, Animalc. Infus. taf. 7. f. 12., 1786. *Vibrio acerosus* Schrank, Fauna boica, 111. 2. p. 47., 1803. *Baccillaria multistriata* Hempritch et Ehrenberg, Symbolæ Physicæ, Phytozoa,

pl. ii. Sanaitica, f. 9. 1828. *Closterium multistriatum*, Abhandl. der Akademie d. Wissensch. zu Berlin, 1829, p. 15—20. *Closterium acerosum*, Symbolæ Physicæ, Evertebrata, text 1830 (1831); Polygastrica, fol. b. a. 2. *Closterium acerosum*, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 68. *Closterium Lunula* Morren, fig. 43.; Ehr. Infus. p. 93. pl. vi. fig. 1. *Cymbella Hopkirkii* Moore, in Ord. Survey; Harv., in Manual, p. 215. *Cl. acerosum* Jenner, in Flora of Tunbridge Wells, p. 196. *Conf. ovata*, Flora Glottiana.

Hab. Near Glasgow: *Mr. Hopkirk.* About Lisburn and in one of the caves, Cave Hill, Belfast: *Mr. Moore.* Warbleton, &c.: *Mr. Jenner.* Galway: *M^c Colla.*

There is no species hitherto described with which it is necessary that this should be compared, the straight and fusiform frond rendering it clearly distinct from all other recorded species. This species was named by Mr. Moore *Cym. Hopkirkii*, in memory of Mr. Hopkirk, author of "Flora Glottiana."

e. Closteria *straight, not lunar.*

12. Closterium Trabecula *Ehr.*

Plate LXXXVIII. Fig. 3.

Char. Frond *broad, longitudinally symmetrical, somewhat quadrangular.* Granules *scattered or disposed in several series.* Endochrome *fasciated.* Bands *several.*

Closterium Trabecula, Abhandl. der Akademie d. Wissensch. zu Berlin, 1830, p. 62. 70.; 1831, p. 68.; Ehr. Infus. 93. pl. v. fig. 2.; Jenner, in Flora of Tunbridge Wells, p. 196.

Hab. Rusthall Common; Piltdown Common; Scrubbs, Colebrooke Park; Waterdown Forest: *Mr. Jenner.*

This *Closterium* bears some resemblance in form at least to *Cl. margaritaceum*, but differs from that species in being altogether much larger, in its entire margins and in the posi-

tion of the vesicles containing the active molecules, which in *Closterium Trabecula* as in all other *Closteria* hitherto described are placed near to each extremity of the frond.

13. Closterium margaritaceum *Ehr.*

Plate LXXXVIII. Fig. 5.

Char. Frond *cylindrical, narrow, two to eight times as long as broad, somewhat quadrangular, often slightly constricted, striated.* Striæ *denticulated.* Cells *containing the revolving particles distant from each extremity.*

Ehr. Infus. p. 93. pl. v. fig. 13.; Jenner, in loc. cit. p. 196.

Hab. Piltdown Common; Warbleton; and in the pond between Ramslye and Broadwater Forest: *Mr. Jenner.*

A distinct and very interesting little species: it is some eight or ten times smaller than *Cl. Trabecula.*

14. Closterium Digitus *Ehr*

Plate LXXXVIII. Fig. 4.

Char. Frond *broad, ovate, cylindrical, four or five times as long as broad; transverse* lines *of division sometimes triplex.* Endochrome *fasciated.* Bands *five or six, often waved.*

Closterium digitus, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 68. *Pleurosicyos Myrio(po)dus* Corda, Almanac de Carlsbad, 1835, p. 182. t. 5. f. 68, 69. *Cl. Digitus?* Menegh., l. c. p. 236.

Hab. Bogs at Fisher's Castle, Ashdown Forest; Scrubbs, Colebrook Park, and between Heathfield and Warbleton: *Mr. Jenner.* Aberdeen: *Dr. Dickie.*

This is one of the finest and most distinct of the numerous species described by Ehrenberg, whose figures of *Closteria* are most beautiful and accurate, and whose descriptions are not less so. The species of this genus being for the most

part of considerable size do not require for their satisfactory examination the high and delicate powers with which most of the *Desmideæ* need to be examined.

60. TETMEMORUS *Ralfs.*

Char. Frond *elongated, straight, subcylindrical, slightly constricted in the centre.* Segments *emarginate at their extremities but otherwise entire, being neither lobed nor sinuated.*

Derivation. From τεμνω, *to cut.*

The two species for the reception of which this genus has been created are placed by Meneghini in the genus *Closterium* with the other species of which they do not well accord.

From *Closterium* it differs in the emarginate extremities of the segments, and in the absence of the cells containing the revolving particles: from *Cosmarium* it is separated by the divided segments, as well as by its elongated fronds.

From *Euastrum*, with which it agrees in the terminal division of the segments, it differs in being neither lobed nor sinuated.

1. TETMEMORUS BREBISSONI *Ralfs.*

Plate LXXXIX. Fig. 5.

Char. Frond *about five times as long as broad, considerably constricted in the centre.* Segments *in the front view somewhat quadriform, but in the lateral view attenuated, longitudinally striated.* Granules *in a row down the centre of the frond.*

Closterium Brebissoni Menegh., Syn. Desmid. in Linnæa, 1840, p. 236. *Closterium* (sp. 9.) Bailey, American Bacillaria, in Amer. Jour. of Science and Arts, vol. xli. No. 2. pl. i. fig. 38. *Tetmemorus Brebissoni* Ralfs, Ann. vol. xiv. p. 258. pl. viii. fig. 1.; Jenner, in Flora of Tunbridge Wells, p. 198.

Hab. Bogs at Fisher's Castle; Waterdown Forest; Piltdown Common; Cross in Hand, &c.: *Mr. Jenner.* Dolgelly, Caermarthen, and Penzance: *Mr. Ralfs.* High Beech: *A. H. H.* Aberdeen: *Dr. Dickie.*

The fronds when empty are found to be minutely punctate, the puncta being arranged in longitudinal rows. It differs from *Tetmemorus granulatus* in its form altogether and in its puncta arranged in longitudinal lines.

2. Tetmemorus granulatus *Ralfs.*

Plate LXXXIX. Fig. 6.

Char. Frond *six or seven times as long as broad, tapering both in front and lateral views, but slightly constricted in the centre.* Segments *rounded at the extremities and terminating in a colourless, projecting, lip-like process, punctated.* Puncta *arranged in diagonal lines.* Granules *in a row down the centre of the frond.*

Closterium granulatum Breb., in Menegh. Synop. Desmid. p. 236. *Tetmemorus granulatus* Ralfs, in Annals of Nat. Hist., vol. xiv. p. 257. pl. viii. fig. 2. *T. granulatus* Jenner, in Flora of Tunbridge Wells, p. 198.

Hab. Bogs at Fisher's Castle; Scrubbs, Colebrook Park, Waterdown Forest; Ashdown Forest, and Cross in Hand: *Mr. Jenner.* Dolgelly and Penzance: *Mr. Ralfs.* High Beech: *A. H. H.* Aberdeen: *Dr. Dickie.*

Tetmemorus granulatus differs from the preceding species in several respects. In the form of the frond, which is altogether different, being quadriform in *T. Brebissoni*, and fusiform in the present species, in the remarkable lip-like projection of the extremities of the segments, and in the arrangement of the puncta in diagonal and not longitudinal lines. Near the junction of the segments the puncta are observed to be arranged in three or four transverse lines.

This species has been found by Mr. Ralfs in a state of conjugation, and with the sporangium formed similar to that

of numerous *Closteria*, and not differing from that of *Staurocarpus* amongst the *Conjugateæ*. The steps of the formation of this in *Closterium* and *Tetmemorus* are as follow. Two fronds coalesce, a cell is gradually formed between them into which the endochrome passes from each frond and which finally becomes moulded into a distinct organ or sporangium invested with its membrane.

61. EUASTRUM *Ehr.*

Char. Frond *compressed, deeply divided into two segments.* Segments *longer than broad, usually pyramidal, emarginate at their extremities, and lobed and tuberculated or sinuated.*

Derivation. From εν, *beautiful*, and αστρον, *a star.*

"In this genus Ehrenberg includes *Micrasterias* Ag. (not *Micrasterias Ehr.*) and *Cosmarium;* Meneghini separates the former from it, but includes it in the latter genus. *Euastrum* appears to me to be distinct from both, and especially from *Cosmarium.* It agrees with *Micrasterias* in having lobes and emarginate ends; but the fronds are not incised, nor do the lobes radiate from the centre. From *Cosmarium* it differs in the lobed and emarginate segments, and also in the inflated projections on the surface. These characters will also distinguish it from the other genera of this family."— *Ralfs.**

a. Segments *of the frond deeply lobed, tuberculated.* Terminal lobes *cuneate.*

1. EUASTRUM VERRUCOSUM *Ehr.*

Plate XCI. Fig. 7.

Char. Frond *denticulated.* Segments *three-lobed.* Lobes *broad, subcuneate, with a broad shallow notch between each lobe.*

Euastrum verrucosum, Abhand. der Akademie d. Wissensch.

* Annals, vol. xiv. p. 188.

zu Berlin, 1833 (1832), p. 247.; Ehr. Infus. p. 162. pl. xii. fig. 5.; Ralfs, in Annals, vol. xiv. pl. vi. fig. 3.; Jenner, in Fl. Tunb. Wells, p. 198.; Pritch. Infus. p. 196. fig. 125. *Cosmarium verrucosum* Menegh., Synops. Desmid. in Linnæa, 1840, p. 222.

Hab. Cheshunt: *A. H. H.* Rusthall Common, and Ashdown Forest: *Mr. Jenner.* Penzance: *Mr. Ralfs.*

This is a very distinct species and the only British one of the genus which has a dentated frond.

2. Euastrum oblongum *Ralfs.*

Plate XCI. Fig. 1.

Char. Frond *large, smooth, oblong, oval, dotted, three or four times longer than broad.* Segments *in* front view *five-lobed, semi-oval;* lobes *broad, subcuneate, emarginate: in* lateral view *pyramidal, furnished with six tubercles each.*

Euastrum pecten, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 82. *Euastrum pecten* Ehr., Infus. p. 162. pl. xii. fig. 4.; Pritch. Infus. p. 196. *Echinella oblonga* Grev., in Hook. Br. Fl. vol. ii. p. 398. (1830). *Cosmarium oblongum* Menegh., l. c. p. 221. *Eutomia oblonga* Harv., Man. Br. Al. p. 188.; Ralfs, in Annals, vol. xiv. p. 189. pl. v. fig. 4.; Jenner, in Fl. Tunbridge Wells, p. 198.

Hab. Bogs at Fisher's Castle; Rusthall Common; Warbleton, &c., Beckley: *Mr. Jenner.* Penzance, Dolgelly, and Caernarvon: *Mr. Ralfs.* Aberdeen: *Dr. Dickie.* High Beech: *A. H. H.*

This is the finest species of the genus, and a beautiful microscopic object, as are most of the species of this genus.

3. Euastrum Pelta *Ralfs.*

Plate XCI. Fig. 3.

Char. Frond *three times as long as broad, subquadrilateral,*

compressed, dotted. Segments *in* front view *three-lobed; lateral* lobes *each twice slightly emarginate: in* lateral view *much compressed.*

Cosmarium Pelta Corda, Almanac de Carlsbad, p. 121. *C. Pelta* Menegh., Synops. Desmid. p. 222. *Euastrum Pelta* Ralfs, in Annals, vol. xiv. pl. vii. f. 1.; Jenner, loc. cit. p. 198.

Hab. Bogs at Fisher's Castle and on Ashdown Forest; Piltdown Common: *Mr. Jenner.* Dolgelly; Penzance: *Mr. Ralfs.* High Beech: *A. H. H.*

There is no other species with which this need be contrasted.

4. Euastrum Didelta *Ralfs.*

Plate XC. Fig. 8., and Plate XCI. Fig. 11.

Char. Frond *about three times as long as broad, dotted.* Segments *in* front view *pyramidal, and* laterally *usually twice emarginate; in* transverse *somewhat four-lobed, and in* end view *oval.*

Heterocarpella Didelta Turp., Mem. p. 295. (1828). *Heterocarpella polymorpha* Kütz., Synops. Diatom. in Linnæa, 1833, p. 70. fig. 82. *Euastrum ansatum,* Abhandl. d. Akademie Wissensch. zu Berlin, 1831, p. 82.; Ehr. Infus. p. 162. t. 12. fig. 6. *Cosmarium lagenarium,* Almanac de Carlsbad, 1835, p. 206. pl. ii. fig. 26. *Cosmarium Didelta* Menegh., l. c. p. 219. *Euastrum Didelta* Ralfs, in Annals, vol. xiv. pl. vii. fig. 2.; Jenner, in Flora of Tunbridge Wells, p. 198,

Hab. Frequent in Sussex: *Mr. Jenner.* Henfield: *Mr. Borrer.* Cheshunt: *A. H. H.* Barmouth Road: *Rev. T. Salwey.* Caernarvon; Dolgelly, near Carmarthen; and Penzance: *Mr. Ralfs.* Aberdeen: *Dr. Dickie.*

A very distinct species.

5. Euastrum affine *Ralfs.*

Plate XC. Fig. 9.

Char. Frond *about three times as long as broad.* Segments *pyramidal in* front view, *and thrice emarginate; in* lateral view *twice emarginate.*

β Frond *about once and a half as long as broad,* twice *emarginate.*

Euastrum affine Ralfs, in Annals, vol. xiv. pl. vii. fig. 3.

Hab. In peat pools near Dolgelly: *Mr. Ralfs.* High Beech: *A. H. H.* Aberdeen: *Dr. Dickie.*

Fronds about as large as those of *Euastrum Didelta;* the segments somewhat resemble a decanter in form; the base is broad and inflated, and contracted upwards into a wide neck; the terminal notch is deep but not gaping; the body of the segment is broadly emarginate on each side; all the lobes or projections are rounded and the sinuses shallow.

The var. β is probably distinct.

6. Euastrum gemmatum *Ralfs.*

Plate XCI. Fig. 6.

Char. Frond *rather more than twice as long as broad.* Segments *in* front view *scarcely emarginate at their extremities,* laterally *twice so; in* transverse view *eight-lobed, longer than broad; and in* end view *four-lobed.*

β Terminal lobe *emarginate at each side.*

Cosmarium gemmatum Breb., Menegh. l. c. p. 221. *Euastrum gemmatum* Ralfs, Ann. vol. xiv. p. 191. pl. vii. fig. 4.; Jenner, in Flor. Tunbridge Wells, p. 198.

Hab. Near Dolgelly: *Mr. Ralfs.* Scrubbs, Colebrook Park, and on Ashdown Forest, in the great bog near Forest Row: *Mr. Jenner.*

"Fronds rather smaller than those of *E. Didelta,* nearly three times as long as broad. Each segment consists of a broad basal portion which is somewhat quadrilateral and emarginate

at each side, and suddenly contracted to form the very short neck; the terminal lobe has each side elongated and rounded entire in *α* and slightly emarginated in *β*; the terminal notch is very obscure. The transverse view is twice as long as broad, with two rounded projections at each end, and three on each side, and a small central opening at the original junction-point of the segments." — *Ralfs.*

7. Euastrum circulare *Hass.*

Plate XC. Fig. 5.

Char. Frond *about twice as long as broad, small, smooth; each* segment *anteriorly occupied with seven tubercles, five at the basal, and two at the distal extremity, four of the five basal tubercles disposed in a half circle around the fifth.*

Hab. High Beech: *A. H. H.*

A very distinct little species.

b. Segments *with acute angles, sometimes prolonged into spinous processes not generally tuberculated.*

8. Euastrum rostratum *Ralfs.*

Plate XCI. Fig. 8.

Char. Basal lobes *of the segments broad and emarginate.* Terminal lobe *with a curved acute spine-like process on each side.*

Euastrum rostratum Ralfs, in Annals, vol. xiv. pl. vii. f. 5.

Hab. In freshwater pools near Dolgelly: *Mr. Ralfs.*

"Frond very minute, about twice as long as broad; segments obscurely three-lobed, or rather with a broad base, which is emarginate on each side, and then contracted into a broad short neck, connecting it with the terminal lobe. The terminal portion has on each side a curved subacute tubercle or process, somewhat like a beak; the end of the lobe is prominent, generally angular, with a deep rounded terminal notch."

9. Euastrum spinosum *Ralfs.*

Plate XCI. Fig. 9.

Char. Frond *minute, somewhat oval, compressed, rather better than twice as long as broad.* Segments *twice emarginate at the side.* Angles *often spinous, especially the distal ones.*

Euastrum spinosum Ralfs, in Annals, vol. xiv. p. 192. pl. vii. fig. 6.; Jenner, Flor. Tunbridge Wells, p. 198.

Hab. Cheshunt: *A. H. H.* Barmouth: *Rev. T. Salwey.* Mayfield; Rusthall Common; Piltdown Common; Chiltington Common; and Rackham, near Pulborough; Dolgelly; Penzance: *Mr. Ralfs.*

A distinct though variable little species, and one by no means uncommon.

10. Euastrum binale *Ralfs.*

Plate XCI. Figs. 4, 5.

Char. Frond *about twice as long as broad.* Segments *concave or truncate, at the end not projecting beyond the acute angles.*

α "Segments *inflated at the base, the notch broad, forming a concavity between the angles.*"

β truncatum. — "Fronds *quadrilateral; the* end *truncate, acute at the angles, with a small triangular notch in the middle;*" segments *laterally twice crenate.*

Heterocarpella binalis Turp., Kützing, Synops. Diatom. p. 70. *Cosmarium binale* Menegh., Syn. Desmid. p. 221.; Ralfs, in loc. cit.; Jenner, in loc. cit., p. 198.

Hab. Mayfield; Piltdown Common, and bog near Cross in Hand: *Mr. Jenner.* Dolgelly; Penzance: *Mr. Ralfs.*

The variety *β* may prove to be distinct.

62. MICRASTERIAS *Ag.*

Char. Frond *compressed, deeply divided into two segments.* Segments *lobed, radiant, and incised.*

Derivation. From *μικρος, small,* and *αστεριας, starred.*

The flat and orbicular fronds, and the radiant and incised lobes, will distinguish this at once from all other genera of *Desmideæ.*

The genus *Micrasterias* of Agardh differs entirely from the *Micrasterias* of Ehrenberg, which has been referred to the *Pediastrum* of Meyen.

1. MICRASTERIAS ROTATA *Ag.*

Plate XC. Fig. 1.

Char. Fronds *smooth, orbicular, ten-lobed.* Lobes *cuneate, approximate, the end lobe emarginate, the others bifid, the divisions being notched.*

Micrasterias rota Menegh., Synops. Desmid. in Linnæa, 1840, p. 215. *Echinella rotata* Grev., in Hook. Br. Flora, vol. ii. p. 398. (1830). *Eutomia rotata* Harv., Br. Alg. p. 187. *Euastrum rota* Ehr., Infus. p. 167. tab. 12. fig. 1.; Pritch. Infus. p. 195. figs. 121—123.; Bailey, American Bacillaria, pl. i. fig. 22. and fig. 24. *Micrasterias* Ag., Bot. Zeit. 1827.? *Cosmarium stellinum* et *C. truncatum* Corda, Almanac de Carlsbad, 1835, p. 206. pl. ii. pp. 22, 23.; Ralfs, in Annals, vol. xiv.; Jenner, in loc. cit. p. 198.

Hab. Frequent in Sussex: *Mr. Jenner.* Henfield: *Mr. Borrer.* About Barmouth: *Rev. T. Salwey.* Aberdeen: *Dr. Dickie.* Stevenston, Ayrshire: *Rev. D. Landsborough.* Penzance; Dolgelly; &c.: *Mr. Ralfs.* Cheshunt Common: *A. H. H.*

The frond of this species in its young condition differs so much from the adult form that it might be easily regarded as a distinct production, the lobes being neither bifid nor dentated.

2. Micrasterias radiata *Hass.*

Plate XC. Fig. 2.

Char. Frond *orbicular, smooth.* Segments *hemispherical each five-lobed.* Lobes *approximate, deeply bifid.* Divisions *divergent, linear, and slightly bidentate.*

Micrasterias melitensis Ralfs, in Annals, vol. xiv. p. 260. pl. vi. f. 2.

Hab. Amongst *Diatoma fenestratum* in a small pool a little below the outlet of Llyn Genernon, near Dolgelly, very rare: *Mr. Ralfs.*

This species is described by Mr. Ralfs under the name of *Micrasterias melitensis,* and as the *Euastrum crux melitensis* of Ehrenberg, which species it seems to me that it assuredly is not. In the true *Micrasterias crux melitensis* the frond is oval, rather than circular, and each segment is three-lobed instead of five-lobed, and the lobes themselves are not approximate but divergent; see Pl. xc. fig. 7. The plant which Ehrenberg figures as the young of his species seems to be referrible to the following genus.

63. HOLOCYSTIS *Hass.*

Char. Fronds *much compressed, formed of two deeply divided segments not incised.* Segments *not divergent.* Lobes *angular, not radiant.* Angles *often spinous.*

Derivation. From ὅλος, *entire,* and κυστις, *a cell;* in allusion to the fact of the segments being entire at their extremities, and not emarginate as in *Micrasterias.*

This genus bears considerable resemblance to *Micrasterias* Ag., from which it differs mainly and essentially in the absence of the radiant disposition of the lobes, which is the chief character of that genus. To it should be referred perhaps the *Euastrum crux melitensis,* pl. xii. fig. 3 c. of Ehrenberg; *Arthrodesmus convergens* Ehr. approaches likewise rather closely to the genus *Holocystis.*

1. HOLOCYSTIS OSCITANS *Hass.*

Plate XC. Fig. 4.

Char. Frond *large, smooth.* Segments *dilated below, contracted above, and again dilated into a large triangular lobe, which is somewhat rounded on its distal side.* Angles *spinous.*

Micrasterias? oscitans Ralfs, MSS.; Jenner, in Flora of Tunbridge Wells.

Hab. On Ashdown Forest, near Duddleswell: *Mr. Jenner.*

Of this species I noticed several fine specimens mixed up with other *Desmideæ* sent me by Mr. Sidebotham.

64. PEDIASTRUM *Meyen.*

Char. Fronds *compressed, circular, or star-like, each composed of several cells, arranged in one or more united concentric circles.* Marginal cells *bipartite.*

Micrasterias Ehrenberg.

Derivation. From πεδιον, *a bond* or *fetter*, and αστρον, *a star.*

The *Desmideæ* are a beautiful tribe of productions; and none of them more so than the subjects of the present genus, which cannot be confounded with any other. Distinct, however, as the genus *Pediastrum* is, considerable difficulty is experienced in the determination of the species, owing to there being no one character which can be depended upon absolutely in their definition; the size of the fronds, number of cells in each, and the degree of incision of the marginal cells varying considerably in each: there is, however, a certain mean in these particulars which enables the observer to determine in most cases the species or variety to which each frond which presents itself to him really belongs.

Meneghini has noticed the occurrrence of transparent vesicles in the cells of the frond, the number of these varying according to the species: he has therefore availed himself of these vesicles in their determination.

1. Pediastrum tetras *Ralfs.*

Plate LXXXVI. Fig. 17.

Char. Fronds *small, cruciform.* Cells *four, deeply bipartite.* Divisions, *truncate, emarginate.*

Micrasterias tetras Ehr., Infus. p. 155. t. xi. f. 1. *Heterocarpella tetracarpa* Bory de St. Vincent, Dict. Classique d'Hist. Nat. 1825. *Heterocarpella polymorpha* Kützing, in part, Linnæa, 1833, t. xix. fig. 82. *Stauridium bicuspidatum, Stauridium crux melitensis* Corda, Almanac de Carlsbad, 1835, pl. iii. figs. 33, 34. *Pediastrum tetras* Ralfs, in Annals, vol. xiv. p. 469. pl. xii. fig. 4.

Hab. Barmouth and Penzance: *Mr. Ralfs.* Beckley Furnace, near Battle, Sussex: *Mr. Jenner.*

A very rare and elegant species, and one of the least variable of the genus.

2. Pediastrum simplex *Hass.*

Plate LXXXVI. Fig. 18.

Char. Frond *constituted of seven cells disposed in a circle, containing in the centre one or two other cells which are emarginate.* Divisions *of the* marginal cells *slightly dentate.*

Pediastrum heptactis Ralfs, in loc. cit.

Hab. Barmouth: *Mr. Ralfs.* Beckley Furnace: *Mr. Jenner.*

Distorted fronds of this species frequently occur, in which the central cell is altered in form and displaced in situation. See Pl. LXXXVI. fig. 18. a. Meneghini describes a single hyaline vesicle in each cell.

Under the name of *Micrasterias heptactis,* Ehrenberg seems to me to have figured two species, fig. 4. a, t. xi., being different from b, c, d, which certainly represent the present plant.

3. Pediastrum elegans *Hass.*

Plate LXXXVI. Fig. 19.

Char. Frond *circular, star-like, composed of six marginal crescentic cells, and two central cells of an angular form.*

Pediastrum Napoleonis Ralfs, in Annals, vol. xiv. p. 470. pl. xii. fig. 6.

Hab. Dolgelly: *Mr. Ralfs.*

The above species, described and figured by Mr. Ralfs under the name of *Pediastrum Napoleonis*, and as the *Micrasterias Napoleonis* of Ehrenberg bears no resemblance whatever to the figures given of that species, nor indeed to any of Ehrenberg's figures, save a distant one to fig. 5 e. of pl. xi., which is regarded by the author as a state of *Micrasterias Boryanum*, which it certainly cannot be, as the frond in the figure alluded to is made of ten marginal crescentic cells, and five internal angular cells.

4. Pediastrum Boryanum *Menegh.*

Plate LXXXVI. Fig. 13.

Char. Frond *composed usually of two circles of cells, enclosing a central cell, but sometimes there are three and even four concentric circles, inner circle formed of five cells, and second circle of ten.* Marginal cells *deeply bifid.*

Helierella Boryana Turpin, Mém. du Mus. vol. xvi. p. 319. pl. xiii. fig. 22. 1828. *Pediastrum simplex, P. duplex, P. biscidiatum* Meyen, Nov. Act. Nat. Cur. xiv. 1829, p. 772, 773. t. 3. figs. 7. 13, 14. 16, 17, 18.; Isis, 1830, p. 163. *Opharium speciosum, O. formosissimum,* et *O. verticillatum* Losano, Mem. de Zarino, xxxiii. 1829; Isis, 1832, p. 768. t. xiv. figs. 17, 18. 21. *Micrasterias simplex, M. Boryi, M. duplex,* et *M. Selancea* Kützing, Linnæa, 1833, p. 601. 3. t. xix. fig. 92 b. *Euastrum pentangulare* et *Pediastrum quadrangum* Corda, Almanac de Carlsbad, 1835, p. 206. 7. t. iii. figs. 32. 35. *Mi-*

crasterias Boryana Ehr., Infus. p. 157. pl. f. 5. a. c. x. k, h, l, f, g, but not b, c, d, e. *Micrasterias tricyclia* Ehr., Infus. p. 158. pl. xi. f. 8. b, c, d, f, g, e, i, but not a. *Pediastrum Boryanum* Menegh., Synops. Desmid. p. 210.; Bailey, American Bacil. fig. 20. *Pediastrum Boryanum* Ralfs, in Annals, vol. xiv. p. 470. pl. xii. fig. 7. in part 1.

Hab. Cheshunt, Herts: *A. H. H.* Brambletye, near Forest Row; Tunbridge Wells, &c.: *Mr. Jenner.* Dolgelley; Barmouth; and Penzance: *Mr. Ralfs.*

It appears to me that more than one species has been confounded together by different observers, and regarded as the present plant. Ehrenberg has figured four species under the name of *Micrasterias Boryana*, one of these being referrible to the *Micrasterias tricyclia* of Ehrenberg, pl. xi. fig. 7. *a*, a plant which is British, and Mr. Ralfs, probably three species, the one of these being doubtless identical with Ehrenberg's *Micrasterias angulosa*. The *Pediastrum Boryanum* is the commonest species of the genus.

"Sometimes plants are met with having more than three circles: these are probably the *Micrasterias elliptica* Ehr., Infus. p. 158. tab. xi. fig. 9., which Meneghini refers to the present species. I am not, however, satisfied that it is not distinct: the external cells agree with the description given above, but the inner ones are variable in number, and not arranged in regular circles. Whether it possesses any other distinctive character I have not yet clearly ascertained. This form is fig. 21. of the American 'Bacillaria.'" — *Ralfs.*

5. Pediastrum tricyclium *Hass.*

Plate XCII. Fig. 1.

Char. Fronds *usually constituted of three circles, the inner circle formed of four or five cells placed round a central cell, the second circle of eight or ten cells, and the third circle of fifteen cells.* Cells *somewhat quadriform, those of the centre as well as the marginal ones usually incised.*

M. Boryana Ehrenberg, Infus. p. 157. pl. xi. fig. 5. i, b. *Micrasterias tricyclia*, pl. xi. fig. 8. a, but not b, c, d, e, f, g, h, i, k.

Hab. In a pond in a brick-field Notting Hill: *A. H. H.*

This appears to me to be a very distinct species. The central cells are not always placed in exact apposition with each other, frequently intervals or triangular interstices are left between them. Ehrenberg has strangely confounded the *Pediastrum Boryanum* with this species, and on the other hand this species with *P. Boryanum*.

6. Pediastrum angulosum *Hass.*

Plate LXXXVI. Fig. 14.

Char. Fronds *constituted of two concentric circles of cells surrounding a single central cell, the first circle being formed usually of five cells and the second of ten.* Marginal cells *alone incised.*

Micrasterias angulosa Ehr., Infus. p. 158. pl. xi. fig. 6. *Pediastrum Boryanum* Ralfs, loc. cit. p. 470. pl. xii. fig. 7. in part 1.

Hab. England.

There can be scarcely a doubt of the distinctness of this species. It is figured by Mr. Ralfs as the *Micrasterias Boryana* Ehr., with which species it has no affinity. Mr. Ralfs' figure accords closely with Ehrenberg's of *Pediastrum angulosum*.

7. Pediastrum constrictum *Hass.*

Plate LXXXVI. Figs. 15, 16.

Char. Frond *large, composed of two or three concentric circles of cells surrounding a single central cell, five cells in the inner circle, ten in second, and fifteen in the outer circle.* Marginal cells *toothed, teeth constricted.*

Pediastrum Boryanum var. Ralfs, in Annals, pl. xii. fig. 8.

This species differs so considerably in the form of the marginal cells, that it is difficult to conceive it to be merely a variety of that species. None of Ehrenberg's figures come near to it. Pl. xi. fig. 5. d. E. represent distinct species of *Pediastrum*, which have not been described as such, and the first of which might be named *Pediastrum cribriforme*, and the second *P. lunare*. See Plate XCII. figs. 3, 4. Several other species of *Pediastra* are represented in Ehrenberg's figures, and confounded with other species. These I propose to figure in an appendix to this genus, in the hope that they may attract the attention of those who study the beautiful tribe of *Desmideæ*.

65. SCENEDESMUS *Meyen.*

Char. Frond *composed of from two to ten cylindrical, fusiform or oblong cells disposed in one or two series, outer ones often lunate.*

Derivation. From σκηνη, *a tent*, and δεσμος, *a bond.*

Arthrodesmus Ehrenberg, in part.

1. SCENEDESMUS QUADRICAUDATUS *Breb.*

Plate XCII. Fig. 12.

Char. Cells *usually four, but sometimes there are eight in each frond, rounded at the ends, disposed in a single series, each* extremity *of the two external cells prolonged into a bristle.*

β Cells *rather small, external ones with a bristle at each extremity, and one at the outer margin.*

γ *ecornis* Ehr. — External cells *without bristles.*

Breb. Alg. Falaise, p. 66. Menegh. Syn. Desmid. in Linnæa, 1840, p. 206. *Arthrodesmus quadricaudatus* Ehr., Infus. p. 150. t. 10. fig. 16.; Pritch. Infus. p. 189.; Ralfs, in Annals, vol. xv. pl. xii. fig. 4.; Jenner, in Fl. of Tunbridge Wells, p. 200. — γ *ecornis. Scenedesmus*

Leibleini. Kütz., Synops. Desmid. in Linnæa, 1833, p. 607. fig. 98.; Menegh., l. c. p. 207. *Scenedesmus bijugatus, trijugatus,* and *minor* Kütz., l. c. p. 607. figs. 97. 99.; Jenner, l. c. p. 200.

Hab. Storrington Common and Eastbourn, Sussex; Shoreham, Kent: *Mr. Jenner.* Cheshunt: *A. H. H.* Dolgelly: *Mr. Ralfs.*—*β.* Dolgelly: *Mr. Ralfs.*—*γ.* Weston Bogs, near Southampton: *Mr. Jenner.* Bristol: *Mr. Thwaites.* Dolgelly, and Penzance: *Mr. Ralfs.*

The cells in this species are quadrangular, about three times as long as broad, and rounded slightly at their extremities; the external ones are usually more turgid, and the bristles at their extremities are directed outwards. The variety *β* and *γ* are figured by *Ehrenberg.*

2. Scenedesmus dimorphus *Kütz.*

Plate XCII. Fig. 13.

Char. Cells *from four to eight in each frond, arranged in a single series.* Inner cells *fusiform, attenuated at each end;* outer *externally lunate.*

Achmanthis dimorpha and *bilunulata* Turpin, Mém. du Mus. xvi. p. 309. pl. xiii. f. 11, 12, 1828. *Scenedesmus pectinatus* Meyen, Nov. Act. Nat. Cur. xiv. p. 375. tab. 43. f. 34. 1829. *Scenedesmus bilunulatus, dimorphus, pectinatus* Kütz., Synops. Diat. Linnæa, 1833. 608. t. xix. fig. 93.; Ehr. Die Infus. p. 150. tab. x. fig. 17.; Ralfs, in Annals, p. 403. pl. xii. fig. 5.

Hab. Dolgelly: *Mr. Ralfs.* Near Bristol: *Mr. Thwaites.*

This is a very distinct and pretty species.

3. Scenedesmus acutus *Meyen.*

Plate XCII. Fig. 14.

Char. "Cells *two to six, fusiform, acute at both ends, un-*

equally ventricose, arranged in a double, irregularly alternating series."

Arthrodesmus acutus Ehr., Infus., p. 150. tab. 10. fig. 19. c, d; Meneg. l. c. p. 207.; Kütz. l. c. p. 609. fig. 96.; Ralfs, in Annals, vol. xv. p. 403. pl. xii. fig. 6.

"I notice this species because the Rev. M. J. Berkeley has gathered it near King's Cliff, and I have occasionally met with specimens which agree with Ehrenberg's figures; but as I omitted to draw up a description at the time, I have borrowed the specific character from Meneghini."—*Ralfs.*

4. Scenedesmus obtusus *Menegh.*

Plate XCII. Fig. 15.

Char. Cells *three to eight, ovate or oblong, with rounded ends, and arranged alternately in two rows.*

Menegh. l. c. p. 208. *Scenedesmus quadralternus* Kütz., l. c. p. 608. fig. 94. *Scenedesmus octalternus* Kütz., l. c. p. 609. fig. 95. *Arthrodesmus acutus* Bailey, Amer. Bacil. fig. 18?; Ralfs, in Annals, vol. xv. p. 404. fig. 8.

Hab. In boggy pools, Dolgelly: *Ralfs.*

"The specimens I have examined did not agree in every respect with the description and figures of this species, but they probably belonged to it. The cells were ovate, the broad ends of the rows placed alternately, the smaller ends being in different directions; sometimes the cells seemed only held together by the hyaline matrix, in which state they appear to connect the *Desmideæ*, through *Gonidium* Ehr. and *Trochiscia* Kütz., with the *Ulvaceæ*. The cells of one row are separated by the interposition of the broader ends of the other."—*Ralfs.*

Note. Several of the figures of this family, especially certain of those of the genera *Euastrum* and *Cosmarium*, are taken from those of Jenner and Ralfs, illustrating the series of papers on the *Desmideæ* inserted in the "Annals."

ALGÆ SILICATÆ.

FAM. XX. *DIATOMACEÆ.

Char. Algæ *silicious.*

THE *Diatomaceæ* form a group of natural productions not less distinct and remarkable than the previous one of *Desmideæ*, with which it may be contrasted.

The *Desmideæ* are *Algæ* of figured and peculiar forms, binary composition, vivid green colour, destitute of silex in their constitution, and therefore subject to considerable change of form in drying.

The *Diatomaceæ* are productions possessing also, to a certain extent, figured forms, but are not binary, of excessive fragility, of a dark brown colour, which changes somewhat to green on drying, of a metallic lustre and silicious composition, and therefore unalterable in drying, and indestructible by fire.

The silex which enters so abundantly into the composition of these plants is disposed throughout the interior of the frustules in plates, which are often arranged in series, which when the frustules are examined microscopically, are seen to impart certain lines or markings to them, which contribute much to their beauty, and which are of importance in the discrimination of genera and species.

It is thus seen how very little connection this group and family of productions has with the undoubted *Algæ* which have hitherto been described; indeed, the claims which they possess to be regarded as subjects of the vegetable kingdom are by no means so conclusive as those which have been advanced in favour of the vegetability of the *Desmideæ*.

But the evidence of which we are in possession would appear greatly to preponderate in proof of the vegetable character of the *Diatomaceæ;* thus, putting aside their silicious constitution, and the partitions in the cells: the filaments of the *Meloseiræ* do not differ in the least in their modes of developement and growth from those of the *Vesiculiferæ,* nor indeed do those of *Fragilaria* differ very essentially from the filaments of the true *Algæ;* in their reproduction, likewise, so far as this has been ascertained, the *Diatomaceæ* correspond with the *Desmideæ,* and perhaps with all the lower *Algæ.*

In support of their animal nature may be urged their colour, which is different from that of all other undoubted vegetable productions, and the silex of which they are principally constituted. These arguments, however, are not conclusive, nor are they of as much weight as those adduced in proof of their vegetability. It is probable that in this matter, as in many other disputed points, the truth lies in the mean, and that the *Diatomaceæ* are neither exclusively animal, nor exclusively vegetable, but of a nature intermediate.

Owing to the presence of silex, the most indestructible of substances, the species of this family are frequently found beautifully preserved in a fossil state, and often in amazing quantities all over the world. In the arts, the powder which they form has been employed for polishing. Many of the fossil species are identical with those now found in a recent state.

Section i.

Frond *filamentous.*

A. Filaments *cylindrical.*

66. MELOSEIRA *Ag.*

Char. Filaments *cylindrical, subulate.* Cells *divided in the centre or bilocular, sometimes vesicular.* Junction surfaces *of the cells either rounded or truncate, plain or striated.*

Derivation. From μελος, *a member*, and σειρα, *a chain.*

The species of the genus *Meloseira* admit of division into two subgenera. The first of these, the species of which are chiefly marine, and to designate which the word *Sphærophora* * might be employed, are characterized by a peculiar form and structure of the cells. The extremities of these are rounded, and each contains, at first, one, and afterwards two spherical vesicles or globules, divided by strongly marked double lines. In consequence of there being no distinct articulating surfaces, the filaments are excessively fragile, so that it is rare to find one of any length.

In the second subgenus, with which we have chiefly to do, and the species composing which are, for the most part, inhabitants of freshwater, the cells are truncate at their extremities, so that their articulating surfaces are directly applied to each other, and simply bilocular, and not globuliferous. This subgenus admits also of further division, according as the articulating surfaces of the cells are either plain or serrated, and striated.

The genus *Meloseira*, amongst the *Diatomaceæ*, seems to have been constituted with a view of making apparent the affinity which undoubtedly exists between the *Diatomaceæ* and the *Algæ* proper, not merely in form and developement approximating so closely to the genus *Vesiculifera* amongst the true *Confervæ*, but also in a measure in its reproduction. As in *Vesiculifera*, at a certain period, particular cells lose their cylindrical form, and become globular or vesicular, and contain endochrome: here, however, the analogy would appear to cease; for this endochrome, so far as my observation goes, never becomes condensed into a distinct organ or sporangium similar to that with which we are familiar in the families *Conjugateæ* and *Desmideæ*. Notwithstanding this striking resemblance to a genus of the *Confervæ*, the *Meloseiræ* are true members of the family of *Diatomaceæ*, as is clearly indicated by their silicious nature, and consequent striated structure.

* *Derivation.* From σφαιρον, *a globule*, and φορεω, *to bear.*

The species are all included by Ehrenberg in his genus *Gallionella.*

a. Filaments *not globuliferous.*

* Extremities *of the cells serrated at the edges.*

1. MELOSEIRA ARENOSA *Moore, MS.*

Plate XCIII. Figs. 2, 3.

Char. Filaments *large, dark brown.* Frustules* *twice or even three times broader than long, divided in the centre by a double line.*

Gallionella varians Ehr., Die Infus. p. 167. t. 21. fig. 2. *Meloseira arenosa* Moore, MS. *M. arenaria* Ralfs, in Annals, vol. xii. p. 349. pl. ix. fig. 4.

Hab. On a wet bank near Larne, co. Antrim: *Mr. Moore.* Inner extremity of the Giant's Causeway: *Mr. W. Thompson.* Very sparingly in a stream near Shoreham, Kent: *Mr. Jenner.*

This is by far the finest species of the genus, and is evidently the plant which Ehrenberg had in view as the *Meloseira varians* of Agardh, his description of that plant being as follows: —

"Corpusculis utrinque planis, cylindricis aut nummiformibus, a dorso glabris, a latere radiatim striolatis, ovariis flavis aut flavo-viridibus."

It is probable, as Ehrenberg has correctly figured both species, that he regarded the true *Meloseira varians* of Agardh as the young state of his species.

The end surfaces of the frustules are closely applied to each other, faintly marked with radiating striæ with their margins serrated, the teeth of one frustule locking into those of the other with which it is in contact, in the same manner as the teeth of certain wheels are made to fit each other.

The name should be *arenosa*, and not *arenaria.*

* The term frustule, applied to the *Diatomaceæ*, has the same meaning as the word cell used to describe the *Confervæ.*

2. Meloseira orichalcea *Kütz.*

Plate XCIII. Figs. 6, 7.

Char. Filaments *rather slender, when recent of a fawn colour.* Frustules *two or three times longer than broad, twice divided near the centre.*

Kützing, in Linnæa, 1833, p. 71. fig. 68. *Gallionella aurichalcea* Ehr., Die Infus. p. 168. t. 10. fig. 6.; Amer. Bacil. part 2. p. 5. pl. xi. fig. 4 b.

Hab. In ditches and slow streams, Cheshunt: *A. H. H.* Stevenston, Ayrshire: *Rev. D. Landsborough.* Dolgelly: *Mr. Ralfs.*

This species differs from *Meloseira varians*, with which it might be confounded, in its smaller filaments, different colour, longer frustules, in the double division of these, and especially in the dentated margins, by which *M. orichalcea* is related to *Meloseira arenosa*, and which is the only character in common between the two species. The *Gallionella distans* of Ehr. comes close to this species, if it be not identical with it.

** Margins *of the cells smooth.*

3. Meloseira varians *Ag.*

Plate XCIII. Figs. 4, 5.

Char. Filaments *rather thick, dark brown, becoming greenish in drying.* Frustules *once or once and a half as long as broad, once divided in the centre.*

Ag. Conspect. Diatom. p. 64.? Kütz. in Linnæa, p. 71. fig. 69.; Harv. Br. Alg. p. 195. *M. lineata* Ag., Syst. p. 8.; Harv. in Manual, p. 195. *Gallionella varians* Ehr., Die Infus. t. 10. fig. 4. *G. aurichalcea* Bailey, Amer. Bacil. part 2. pl. 2. fig. 4 c. *Conf. lineata* Dillw., p. 44. t. β Jurg, Dec. 5. No. 18. *Conf. hyemalis* Jurg, Dec. No. 17. No. 6. *Vesiculifera composita* Hassall, in Annals of Nat. Hist. vol. x. p. 394.; Ralfs, in Annals, vol. xii. p. 350. pl. ix. fig. 5.

Hab. Everywhere common in ditches and rivulets.

"In a stream below Penmaen Pool, near Dolgelly; and within the influence of the tides, I have gathered a tufted state of this species of a bluish colour, not unlike the iridescent tints of *Cystoseira ericoides.* It was growing with *Ectocarpus littoralis.* I have also for several years observed it in the same state in a cave by the sea side at Penzance; in both instances it afterwards became brownish, and finally green." — *Ralfs.*

It is on this species that the inflated vesicles usually occur, and which formerly induced me to refer it to a section of the genus *Vesiculifera.*

4. Meloseira ochracea *Ralfs.*

Char. "Frustules *very slender, convex at each end, ovate, not striated, ferruginous.* Filaments *often connected together in a subramose manner.*"

Gallionella ferruginea Ehr., Die Infus. p. 169. t. 10. fig. 8., and t. 21. fig. 3. *Conf. ochracea* Dillw., t. 62. *Oscillatoria ochracea* Grev., Flor. Edin. p. 304.; Harv. Br. Alg. p. 167. *M. ochracea* Ralfs, in Annals, vol. xii. p. 35.

Hab. Pools and slow streams in boggy soils.

"This plant occurs in delicate ochraceous or ferruginous masses, falling into powder on the slightest touch. The filaments are so slender, and the joints so obscure, that I have been unable to determine the form of the frustules, and have therefore taken the specific character from Ehrenberg: I am also unable to ascertain whether the joints are marked by any central line. Having received from Mr. Dillwyn a specimen of his *Conf. ochracea,* which I am able confidently to refer to this species, I have restored the original specific name. Ehrenberg is no doubt correct in placing the plant in this genus, as the filaments are cylindrical and silicious.

"When submitted to a red heat it acquires a reddish tinge,

which circumstance, together with the colour and slender filaments, will distinguish it from all other species." —*Ralfs.*

67. ACHNANTHES *Bory.*

Char. Frond *stipitate, standard-shaped, composed of few frustules, which are longer than broad, curved, and have a punctum at the centre of the inferior margin.*

Derivation. From *αχνη, the froth of the ocean,* and *ανθος, a flower.*

The stipes is attached not to the centre of the lower frustule but to one of its angles, and this position of it gives rise to the resemblance of each entire frond to a standard.

1. ACHNANTHES MINUTISSIMA *Kutz.*

Plate C. Fig. 4.

Char. Frustules *small, slender; in* lateral view *obtuse, and apparently without striæ.* Stipes *very short.*

Kütz. Syn. Diatom. p. 578. f. 54.; Ehr. Infus. p. 228. pl. xx. f. 5.; Ralfs, in Annals, vol. xiii. p. 492. pl. xiv. fig. 2.; Jenner, in Flor. of Tunbridge Wells, p. 200.

Hab. Parasitic on other *Algæ,* Newtimber, Sussex: *Mr. Borrer.* Several places in Sussex, &c.: *Mr. Jenner.* Cheshunt: *A. H. H.* Oswestry: *Rev. T. Salwey.* Penzance: *Mr. Ralfs.* Bristol: *Mr. Thwaites.*

The fronds are very minute, and rarely consist of more than two frustules.

"Before I had the opportunity through Mr. Borrer's kindness of comparing our plant with the specimen in Kützing's 'Alg. Aq. Dulc.' I considered it a variety of the following species; and I am still uncertain whether they should be separated, although the plant above described is undoubtedly Kützing's *Achnanthes minutissima.*" — *Ralfs.*

2. ACHNANTHES EXILIS? *Kutz.*

Plate C. Fig. 5.

Char. Frustules *slender, from one to nine in each frond.* Lateral surfaces *subacute.* Striæ *indistinct or wanting.* Stipes *longer than the frustule.*

Kütz. Syn. Diatom. p. 578. f. 53.; Ehr. Infus. p. 228. pl. xx f. 5.; Ralfs, in Annals, vol. xiii. pl. xiv. fig. 12.

Hab. Parasitic on *Gomphonema geminatum* in several streams, near Dolgelly: *Mr. Ralfs.*

From *Achnanthes minutissima* this species differs in its elongated stipes, greater number of frustules in each frond, and in its more acute lateral surfaces.

Although I have compared our plant with Kutzing's *Achnanthes exilis* I am not certain that it is the same species. It agrees with Kutzing's specimen in its crowded habit and elongated stipes, but its frustules are much smaller, and its lateral surfaces less acute, in both which respects it is intermediate between *Ach. minutissima* and Kutzing's specimen of *Ach. exilis.*

B. Filaments *compressed.*

A. Frustules *in front view quadrangular.*

68. TETRACYCLUS *Ralfs.*

Char. Frustules *cohering so as to form a fragile, attenuated filament, never united by their angles, striated strongly laterally; four-sided, each side rounded, and forming the segment of a distinct circle.*

Derivation. From τετρας, *four,* and κυκλος, *a circle.*

This genus differs only from *Tessella* and *Striatella* in the frustules not cohering by the angles.

1. TETRACYCLUS LACUSTRIS *Ralfs.*

Plate XCIII. Figs. 8, 9.

Char. Frustules *about twice as long as broad.* Lateral surfaces *with from seven to nine distinct transverse striæ; in* end view *four-lobed.*

Hab. Llyn Prefeddyr, near Barmouth: *Rev. T. Salwey.* Pools near Dolgelly: *Mr. Ralfs.*

In consequence of the four-lobed form of the frustules composing a filament, and which arises from the inflation of the central part of each frustule, it happens that when examined by the microscope that the centre of one side or lobe is seen together with a portion of two other lobes, one on each side, the boundaries of the lobe in view being indicated by two lines running down the length of the filament. But as the lobes are not all of equal size, those only being so which are opposite to each other in the filament, it follows that the quantity of the other two lobes seen varies according to the side of the filament which is uppermost. Now, the longer sides or lobes are those which form the margins of the filaments, and those which form the centre the shorter, the filament rests of course usually upon one of the shorter lobes: from this it results that in the filaments in their usual position, that a considerable portion of the lateral lobes is seen, but in the cases in which they rest upon their longer or marginal lobes a very small portion only of the lateral lobes is in view. The smaller and shorter lobes correspond to the back and front of the filament, and the larger and longer to the margins, which may be distinguished in addition to their breadth by the presence of striæ, more strongly marked than they are in the centre of the filament: the terminations of the frustules in this view are also punctated, although not contracted. In the marginal view, that is with the margin of the filament uppermost, but a very slight portion of the back and front lobes is seen, the striæ are most strongly marked in the centre, and describe quadrangular spaces, the frustules are contracted also at their points of junction where they present no puncta.

In the end view the frustules have been aptly compared to the *quatrefoil of a gothic window:* in the smaller filaments in this aspect, they are about as long as broad, in the larger one and a half times as broad as long; and each has about seven well-marked striæ, a central straight stria which extends from one marginal lobe to the other, and three curved striæ belonging to each of the front and back lobes.

69. TABELLARIA *Shut.*

Char. Frustules *quadrangular, fusiform, cohering by their angles, traversed in the centre by a longitudinal canal, marked with transverse* striæ, interrupted in the centre by the canal.* End view *destitute of markings.*

Derivation. From *tabella,* a letter; which the frustules resemble in form.

The term *Bacillaria* is applied by Ehrenberg to the species of this and the following genus, as well as to a curious production wholly different from either genus, the *Bacillaria paradoxa,* and to which species I propose that the genus *Bacillaria* should now be confined. By Agardh, the appellation of *Diatoma* is given to them. Mr. Shuttleworth has proposed the division of the genus *Diatoma* into two genera, in the propriety of which I fully concur; for one of these Mr. Shuttleworth reserves the name of *Diatoma,* that of the other is derived from a species named by Ehrenberg *Bacillaria tabellaris,* and which species is typical of the genus.

1. TABELLARIA FLOCCULOSA.

Plate XCIV. Figs. 9, 10.; Plate XCVI. Fig. 11.

Char. Frustules *in young spscimens as long as broad, in older specimens their breadth exceeds their length by two or three times.* Striæ *from one to seven on each side. In* end

* The word *transverse* has here a meaning different to that generally assigned to it; it here has reference to the width of the cell or filament, and not to its depth.

view *frustules dilated in the centre by the canal, with rounded extremities.*

Diatoma flocculosum Ag., Syst. p. 4.; Kütz. in Linnæa, 1833, p. 584. t. 17. f. 67.; Hook. Br. Fl. vol. vii. p. 406.; Harv. Br. Alg. p. 202. *Conf. flocculosa* Dillw., Conf. t. 28.; Eng. Bot. t. 1761. *Bacillaria tabellaris* Ehr., Infus. p. 199. pl. xv. f. 7. *Diatoma flocculosum* Ralfs, in Annals, vol. ix. pl. ix. fig. 3. *Bacillaria flocculosa* Ehr., Infus. t. xv. f. 9. *B. seriata* Ehr., Infus. t. xv. fig. 8.

Hab. Common in pools, &c.

This is a very variable species, and it is not to be wondered at that a difference of opinion should have existed as to whether the conditions of it represented in "Eng. Bot." and in Dillwyn's "Confervæ" were not in reality distinct species. That they are not so, however, is certain, as well as that both are different stages of the growth of the same production. In the young state, the cells are as long and even longer than broad, each side of the frustule being marked with often as many as seven well-marked striæ; and the central canal is large and circular. From this state intermediate specimens are often met with, some having the frustules once and a half, others twice, and others thrice, and even many times as broad as long. Corresponding with this gradual lateral enlargement of the frustules, we find the number of the striæ to diminish gradually, until at last but one or two exist on each frustule, and at the same time, a gradual diminution in the size of the central canal occurs, until at length this is nearly obliterated. Thus the ultimate stage of the species bears some resemblance to *Tabellaria fenestrata*, and is the *Bacillaria seriata* of Ehrenberg. For these changes see the figures.

2. Tabellaria fenestrata.

Plate XCVI. Fig. 10.

Char. Frustules *four or five times longer than broad; in* end view *subinflated in the centre with incrassated ends.*

Diatoma fenestratum Lyngb., Hydr. Dan. t. 61. E. 3.; Ag. Consp. Diatom. p. 53.; Hook. Br. Fl. vol. vii. p. 406.; Harv. Br. Alg. p. 202.; Ralfs, in Annals, vol. xi. p. 453. pl. ix. fig. 4.; Jenner, in Flora of Tunbridge Wells, p. 200.

Hab. Pools, &c.; Sussex, &c.: *Mr. Jenner.* Cheshunt: *A. H. H.* Barmouth, North Wales: *Rev. T. Salwey.* Dolgelly, and near Pont-Aberghas-lyn, North Wales, and Penzance: *Mr. Ralfs.* Stevenston, Ayrshire: *Rev. D. Landsborough.* Aberdeen: *Dr. Dickie.*

This is one of the least variable of the species of this and the following genus; it may however be confounded with *Tabellaria flocculosa* in the last stage of its developement; but with a little care it may be readily distinguished therefrom. In *T. fenestrata* the frustules are connected by a perceptible hinge, and on each fully developed frustule there are at each extremity two striæ. In *T. flocculosa* the mucous hinge is not visible connecting the frustules, which are usually much longer, and on the narrowest, which approach nearest to *T. fenestrata*, there is frequently but a single stria at one side, and two at the other. The end views of the frustules in the two also differ. In *T. flocculosa* the frustule is more slender, the ends less incrassated, and the canal more prolonged.

The frustules in this species and in *D. elongatum* are often curiously thrown back so as to form two lengthened series.

70. DIATOMA *Ag.*

Char. Frustules *not having a central canal or lateral striæ, punctated at the sides, the puncta being produced by the presence of grooves, which pass round the frustules.* Junction surfaces *often striated.*

Derivation. From διατομη, *incision;* the plant looking like a band cut into portions, which cohere only at the angles.

1. Diatoma vulgare *Bory.*

Plate XCIV. Figs. 1, 2.

Char. Frustules *two or three times broader than long, sometimes attached by a stipes.* Lateral puncta *very evident.* End view *inflated, incrassated at the terminations, and striated.*

Diatoma vulgare Kützing, in Linnæa, 1833, p. 582. f. 66.– *D. tenue* Grev., Crypt. Fl. t. 354.; Berk. Brit. Alg. t. 6.? Hook. Br. Fl. vii. p. 406.; Harv. Manual of Br. Algæ, p. 202. *D. tenue a moniliforme* (Young) Kütz., in Linnæa, 1833, p. 580. f. 60.? *D. tenue β intermedium* Kütz., l. c. p. 580. f. 61.? *D. flocculosum* Ag., Consp. Crit. Diatom. p. 53. excl. syn. Dillw. *Bacillaria vulgaris* Ehr., Die Infus. p. 197. pl. 15. f. 2. *Diatoma vulgare* Ralfs, in Annals, vol. xi. p. 450. pl. viii. fig. 8.; Jenner, in Fl. of Tunbridge Wells, p. 202.

Hab. Pools, streams, &c. King's Cliff, Northamptonshire: *Rev. M. J. Berkeley.* Henfield, Sussex: *Mr. Borrer.* Shoreham, Kent, and several stations about Lewes and Tunbridge Wells: *Mr. Jenner.* Shrewsbury: *Mr. Leighton.* Oswestry, Shropshire: *Rev. T. Salwey.* Cheshunt, Herts: *A. H. H.* Ireland: *Mr. D. Moore.*

This species, like most of the *Diatomaceæ*, varies very considerably in the length and breadth of the frustule, as well as in the degree of its convexity. Usually each frustule is about two and a half times as broad as long; in this state the frustules are seen to be very convex in the end view, but sometimes older specimens are met with, in which the breadth of the frustules exceeds some five or six times their length, and in this they are scarcely at all convex when viewed endways. This condition of the species might almost mislead one to regard it as a distinct species. See the figures.

From *Diatoma tenue*, or rather *D. elongatum*, of which *D. tenue* is but a state, with which, however, there is but little danger of confounding it, *D. vulgare* may be distinguished by the greater breadth of the frustules, their con-

vexity in the end view, and the different character of the marginal striæ. Owing to the frustules being convex, not merely in thickness, but having rounded extremities, the striæ are evident on a portion of the front surface.

The species grows most luxuriantly in gently running water, frequently investing *Cladophora glomerata*, and causing it to appear of a deep brown or chocolate colour. It is attached to this plant by means of a stipes, first detected by Mr. Jenner, the existence of which from its locality in flowing water might have been predicted.

In drying it changes to a greenish hue.

2. DIATOMA ELONGATUM *Ag.*

Plate XCIV. Figs. 3, 4, 5, 6.

Char. Frustules *many times as broad as long, at first with straight margins, subsequently, when fully developed, the sides are dilated on the front surface.* End view *linear, with slightly incrassated ends.*— *β cuneatum.* Frustules *wedge-shaped.*

Diatoma tenue Ag., Consp. Diatom. p. 52. *D. tenue δ. normale* Kütz., in Linnæa, 1838, p. 580. t. 17. f. 63. *D. elongatum* Berk., Glean. t. 6.; Hook. Br. Fl. 406.; Harv. Manual, p. 202. *D. sulphurascens* Ag., Consp. Diatom. p. 53. *Conf. flocculosa* Dillw., Br. Conf. t. 28. f. c.? *Bacillaria pectinalis* Ehr., Infus. p. 198. pl. xv. fig. 4. in part only. *D. elongatum* Ag., Syst. p. 4.; Kütz. in Linnæa, p. 582. t. 17. f. 65. *Bacillaria elongata* Ehr., Infus. p. 218. f. 169. *D. tenue* and *D. elongatum* Ralfs, in Annals, vol. xi. p. 451, 452. pl. ix. fig. 1.; *D. tenue* Jenner, loc. cit. p. 202. *Bacillaria cuneata* Ehr., Infus. t. xv. fig. 6. *Diatoma tenue γ cuneatum* Kütz., in Linnæa, 1833, p. 580. t. 17. fig. 62.

Hab. Pools and streams. Near Tunbridge Wells: *Mr. Jenner.* Shrewsbury: *Mr. Leighton.* Cheshunt: *A. H. H.* Bangor, and Dolgelly, North Wales; Penzance: *Mr.*

Ralfs. Aberdeen: *Dr. Dickie.* Stevenston, Ayrshire: *Rev. D. Landsborough.*

This is a very variable species. In the young state the frustules are plain, but in their fully developed condition they are dilated laterally, or as most writers would say, at each extremity. These two states have been separately described as distinct species, but I have no hesitation in uniting them. I have preserved the specific appellation of *elongātum* in preference to that of *tenue*, because the latter term was applied by Ehrenberg to the condition of the species with dilated frustules, in fact to the species in its fully developed or perfect state.

The younger frustules in the end view are slightly dilated in the centre with incrassated ends; in this state they bear a slight resemblance to the older ones of *Diatoma vulgare*, but are much smaller. The fully developed frustules in the end view are linear and very slightly incrassated.

Remarkable as the variety with *cuneate* frustules is, it is I suspect but an anomalous condition of the species.

Light brown or yellow when recent, assuming a faint green tinge in drying.

3. Diatoma virescens *Hass.*

Plate XCV. Figs. 7, 8.

Char. Frustules *usually two or three times broader than long, frequently cohering together in the manner of a* Fragilaria. *In* end view *oval, with slightly constricted extremities.* Striæ *inconspicuous.*

Fragilaria pectinalis Ehr., Die Infus. p. 206. t. 16. f. 1. excel. a; Pritch. Infus. p. 222. fig. 176. *Fragilaria virescens* Ralfs, in l. c. p. 110. pl. 11. fig. 6.; Jenner, l. c. p. 202.

Hab. Cold bath spring, Broadwater Forest; Lower Green; Rotherfield and Piltdown Common: *Mr. Jenner.* Madron and Chyanhal Moor, near Penzance:

Mr. Ralfs. Pond near Wormley, West End, Herts: *A. H. H.*

The greatest peculiarity of this species is, that frequently the frustules cohere together in considerable numbers, so as to form filaments apparently similar to those of *Fragilaria*, but in all probability really distinct. If, however, the specimens be dried or kept in water, these filaments will generally be found broken up in the manner of a *Diatoma*.

The only species with which it needs to be contrasted is *Diatoma vulgaris*, from which it may be distinguished by the absence, or at all events the exceeding fineness of the striæ, on the end surfaces of the frustule, as well as by the filaments, which it usually forms.

The colour is stated to be green, not altering much in drying. In my specimens it has been dark brown, changing to a greenish hue in the herbarium.

The removal of this species from *Fragilaria* to *Diatoma* will render that genus a natural and not an anomalous one.

71. BACILLARIA *Gmelin.*

Char. Frustules *sliding one upon the other.*

Derivation. From *bacillum*, a small stick.

In the genus *Bacillaria* Ehrenberg includes not merely the species of the two preceding genera, but likewise the singular production which forms the type of the limited genus *Bacillaria*.

1. BACILLARIA PARADOXA *Gmelin.*

Plate XCIII. Fig. 10.

Char. Frustules *very many times broader than long, cohering together in considerable numbers upon the same plane, motive upon each other. In* end view *striated.*

F. sonderbares Stabgenthier Müller, Muller's Kleine

Schriften v. Göze, p. 1. fab. 1. 8., 1782; Pinddyr Nye Samling af Dansk Vidensk. Sallsk. Skrift. 11. p. 277. *Vibrio paxillifer* Müller, Animalc. Infus. p. 54. t. 7. f. 3. 7., 1786. *Bacillaria paradoxa* Gmelin, Linnæi Syst. Nat. ed. xiii. vol. vi. 1788. *Vibrio paxillifer* Lamark, Système des Anim. sans Vert. 1815. *Bacillaria palea* Nitzsch, in part, Beiträge zur Infusorienkunde, 1817; Encyclopädie v. Ersch u. Gruber, 1821. *Bacillaria paradoxa* Bory de Saint Vincent, Dict. Classique, 1822. *B. Mülleri* Bory, Encyc. Méth. 1824. *Oscillaria paxillifera* Schrank, Nov. Act. Nat. Cur. xi. 2. p. 534. 539. *Bacillaria Mülleri* Turpin, Dict. des Sc. Natur. Végétaux Acotyledones, 1828. *Bacillaria paradoxa*, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 83.; 1833, p. 319.; Ehr. Infus. p. 196. t. xv. f. 1.

This is the most singular of all the *Diatomaceæ*, and the most protean in the forms which it assumes; the variety of which results from the power which the frustules undoubtedly possess of gliding one upon the other. Sometimes the margins of the frustules correspond in position with each other, and then an elongated lamina is formed similar to that of the *Fragilariæ*. At others the frustules are drawn out from each other by two and three together, and the margins are rendered uneven; and again at others, each frustule composing a frond is drawn out, so that it adheres but by a very small portion of its length to the frustule or frustules, one on each side, with which it is connected. Now this disposition of the frustules could only be effected by the possession of a power of motion the one upon the other.

Ehrenberg in his definition of this species makes use of the following phrase, "baccillis singulis alacriter mobilibus;" and, again, in the definition given in French, "les baguettes vivement mobiles." Now it ought not, I apprehend, to be imagined, as the words quoted would lead us to suppose, that the frustules possess each and individually a power of locomotion centered in themselves, but merely that they are so

loosely aggregated together as that a slight force should occasion a lateral displacement of them. Still it must be allowed to be very singular, that the frustules should not rather separate altogether from each other, than allow so great a displacement as is frequently seen to occur, and yet should retain their adherence.

A separate frustule bears much resemblance to the undilated form of the frustule of *Diatoma elongatum*. Colour yellowish brown.

I am in some doubt as to the precise locality of this production. It was either gathered by the Rev. D. Landsborough at Stevenston, in Ayrshire, and then probably found near the sea, or (what is less likely) by myself, somewhere in the neighbourhood of Cheshunt.

72. FRAGILARIA *Lyngb.*

Char. Filaments *compressed, attenuated, fragile, rarely angular, with, in most cases, two canals or grooves passing round the centre of each frustule, indicated by the presence of puncta on the lateral margins.*

Derivation. From *frango*, to break; in allusion to the brittleness of the filaments.

The genus *Fragilaria* approaches very closely to that of *Diatoma* as restricted in this work; indeed the two genera merge into each other, through *Fragilaria virescens* or rather *Diatoma virescens*. The compressed character of the frond is sufficient to distinguish it and all other *Diatomaceæ* from the genus *Meloseira*.

1. FRAGILARIA PECTINALIS *Lyngb.*

Plate XCV. Figs. 1. 4.

Char. Filaments *large, dark brown.* Frustules *in* front view *quadrangular, two or three times broader than long, longitudinally striated with two evident puncta on the lateral*

margins; in end view *curved with slight constrictions at each extremity, striated.*

β *undulata* Ralfs. — *Convex margin of* end view *of the* frustule *with two indentations;* centre *of concave margin prominent.*

Ag. Syst. p. 7.; Consp. Diat. p. 62.; Grev. in Br. Fl. vol. ii. p. 403.; Harv. Br. Alg. p. 197. *Conf. pectinalis* Dillw., t. 4.; Eng. Bot. t. 1611.; Jurg, Dec. 18. No. 12. *Fragilaria grandis* Ehr., Die Infus. p. 203. t. 15. fig. 11.; Pritch. Infus. p. 220. — β *undulata*, fig. 171.; Ralfs, in Annals, vol. xii. pl. 2. fig. 3. *F. pectinalis* Ehr., pl. xvi. fig. 1 a; Jenner, loc. cit. p. 202.

Hab. Everywhere common in pools, ditches, &c. — β *undulata.* Drws Ardudwy, near Barmouth: *Rev. T. Salwey.* Scrubbs, Colebrook Park: *Mr. Jenner.*

The filaments of this species and others of the genus vary exceedingly in size, or rather in diameter, on account of the cells of the species of the genus developing themselves in breadth as well as length, and this developement occasions the greatest variations in the width of the cells, compared to their length: thus sometimes the cells are longer * than broad in the very slender filaments; at others, as in the longest threads, they are six or seven times broader than long, but usually their breadth exceeds their length only by three or four times.

On the anterior surfaces of the frustules at either extremity, but not extending entirely across them, a delicate row of striæ may be detected: these add greatly to the beauty and interest of the plant, and do not appear hitherto to have been described: they are doubtless formed by the continuation of the striæ observed in the end view of the frustule. Mr. Jenner has

* The terms *length* and *breadth*, when employed in this work in the description of the *Diatomaceæ*, are used in the same sense in which they are employed in the definitions of the *Confervæ*, the breadth of the frustule corresponding to the diameter of the filament, and the length to its longitude. In the *Diatomaceæ* the breadth of the frustule usually exceeds the length.

verified my observation on these minute striæ: when first I observed them, I thought that they were found only in the undulated variety of the plant, and that this therefore might form a distinct species. I am now satisfied, however, that the striæ are to be found in every well-developed specimen; and the difference observed in the end view of the frustules in certain species is indicative of merely a condition of the plant.

A remarkable state of this species has been met with by Mr. Ralfs and Mr. Jenner. In this, within each frustule is enclosed apparently a second frustule of a more or less oval form, and striated laterally in the same way as the extremities of the cells.

Occasionally it happens in this and in other species and genera of *Diatomaceæ* that the cells in their front aspect are not in the form of a parallelogram, but somewhat cuneate: this occurs in consequence of the frustule being divided obliquely, and not by a straight line.

The frustules, Mr. Ralfs observes, have sometimes a central pellucid spot, which does not appear to be connected with the endochrome.

When recent, *Fragilaria pectinalis* is of a dark brown, but in drying it turns to a greyish green, with a metallic lustre.

2. Fragilaria hyemalis *Lyngb.*

Plate XCV. Fig. 5.

Char. Filaments *very fragile.* Frustules *long.* Sides *slightly emarginate, puncta very small.* End view *elliptico-lanceolate, with from two to seven or eight well-marked striæ, which terminate in distinct puncta along the anterior terminal margins of the frustules.*

Lyngb. t. 63.; Ag. Syst. p. 7.; Consp. Diatom. p. 63.; Kütz. in Linnæa, 1833, p. 72. *Fragilaria confervoides* Grev., in Br. Flor. vol. ii. p. 403.? Harv. Br. Algæ, p. 197.; Ralfs, in Annals, vol. xii. pl. ii. f. 3.

Fragilaria turgida Ehr., Infus. pl. xv. f. 13.

Hab. In freshwater pools and rivulets, Sussex: *Mr. Borrer.* Llyn Prefeddyr, near Barmouth: *Rev. T. Salwey.* Aberdeen: *Dr. Dickie.* Stevenston: *Rev. D. Landsborough.* Ballantrae, Ayrshire: *Mr. W. Thompson.* Dolgelly, Tavistock, and Trenteshoe, Devonshire; Penzance, Cornwall: *Mr. Ralfs.*

This is a smaller species than *Fragilaria pectinalis*, differing from it also in the slightly emarginate sides of the frustules, the elliptico-lanceolate form of their end view, and the paucity and decided character of the striæ seen on the end surface.

The filaments are so fragile, that the frustules separate on the slightest touch, so that it is rare to meet with a filament of any length. In most specimens the frustules are as long as broad, and some even longer; but in others, again, they are two or three times broader than long. The filaments not so unequal as in the other British species of the genus. When recent, it is of a dark brownish colour, becoming whitish brown in drying.

There can be no doubt of the correctness of the reference to Ehrenberg.

3. Fragilaria rhabdosoma *Ehr.*

Plate XCV. Fig. 6.

Char. Filaments *much compressed.* Frustules *usually many times broader than long; in the* end view *lanceolate, and without striæ.*

Ehr. Die Infus. p. 204. t. 15. f. 12. *Frag. pectinalis* Kütz., in Linnæa, 1833, p. 73.? *Frag. tenuis* Ag., Conspect. Diatom. p. 63.? Ralfs, in l. c. p. 108. pl. xi. fig. 4. *F. bipunctata, F. angusta, F. scalaris,* and *F. diopthalma* Ehr., t. xv. *F. rhabdosoma* Jenner, in Flora of Tunbridge Wells, p. 202.

Hab. Common in pools and ditches.

The exceedingly narrow frustules, and the lanceolate form

of the end view of these, will distinguish this plant from all other freshwater species.

It is of a pale brown when recent, becoming in drying of a greyish hue with a silvery lustre.

73. EUNOTIA *Ehr.*

Char. Frustules *free, striated laterally, with two superficial grooves running round each, and indicated by lateral puncta.*

This genus differs only from *Fragilaria* in that the frustules never form filaments, as in that genus.

1. EUNOTIA ARCUS *Ehr.*

Plate XCVII. Fig. 5.

Char. Frustules *elongated, striated. In* front view *quadrangular, with straight sides. In* lateral aspect *narrow, curved, constricted towards either extremity.*

Eunotia Arcus, Bericht. der Akademie d. Wissensch. zu Berlin, 1837, p. 45.; Ehr. Die Infus. t. 21. fig. 22.; *Eunotia monodon?* Ehr.; Ralfs, in Annals, vol. xv. p. 459. pl. xiv. fig. 1?; Jenner, in loc. cit. p. 202.

Hab. Cheshunt: *A. H. H.* Piltdown Common: *Mr. Jenner.* Penzance: *Mr. Ralfs.*

A distinct and not uncommon species.

2. EUNOTIA DIODON *Ehr.*

Plate XCVII. Fig. 6.

Char. Frustules *elongated. In* front view *quadrangular, with straight sides. Convex margin of* lateral aspect *bidentate.*

Eunotia Diodon, Bericht. der Akad. d. Wissensch. zu Berlin, 1837, p. 45.; Die Infus. p. 192. t. xxi. fig. 13.;

Jenner, loc. cit. p. 292.; Ralfs, in Annals, vol. xv. p. 460. pl. xiv. fig. 2.; Bailey Amer. Bacil. pl. ii. f. 29.

Hab. Piltdown Common: *Mr. Jenner.*

The teeth or processes in this species are obtuse and but little elevated.

3. Eunotia Triodon *Ehr.*

Plate XCVII. Fig. 7.

Char. Frustules *in* lateral view *semi-lunar, having three obtuse teeth on the convex margin.*

Eunotia Triodon Bericht. der Akademie d. Wissensch. zu Berlin, 1837, p. 45.; Die Infus. t. xxi. fig. 24.; Jenner, in Fl. of Tunbridge Wells, p. 202.; Ralfs, in Annals, vol. xv. p. 461. pl. xiv. fig. 23?; Bailey, Amer. Bacil. pl. ii. f. 30.

Hab. Cold bath spring: *Mr. Jenner.*

A distinct species, noticed hitherto, I believe, only by Mr. Jenner.

4. Eunotia Tetraodon *Ehr.*

Plate XCVII. Fig. 8.

Char. Frustules *in* lateral view *semilunar, with four obtuse teeth on the convex margin.*

Eunotia Tetraodon Mittheilungen der Berl. Naturforsch. Freunde (Berl. Staatszeitung, April 1837); Die Infus. p. 192. t. xxi. fig. 25.; Ralfs, in Annals, vol. xv. p. 461. pl. xiv. fig. 4.; Bailey, l. c., pl. ii. f. 31.

Hab. Piltdown Common, Sussex, and Weston Bogs near Southampton: *Mr. Jenner.*

B. Frustules *wedge-shaped.*

74. MERIDION *Leiblein.*

Char. Frustules *cuneate, united so as to form segments of circles or spirals.*

Derivation. From μερις, *a portion* or *particle.*

This is a very natural genus, differing from *Fragilaria* in the cuneate form of the frustules in the front view, and attenuated outline in the end or lateral aspect, and from *Stylaria* in the number of frnstules, which cohere, and which form more or less considerable portions of circles.

1. MERIDION CIRCULARE *Ag.*

Plate XCVI. Figs. 1—6.

Char. Frustules *very variable in size, broad margin, punctated.* Articulating surfaces *clavate, strongly striated; the ends of the striæ appearing as puncta along the edges in the front view.*

Meridion circulare Ag., Consp. Diatom. p. 40.; Kütz. Synop. Diatom. in Linnæa, 1833, p. 558. f. 37.; Harv. Manual, p. 205. *Meridion vernale,* p. 207. t. 16. f. 2. Bailey's American Bacillaria, in Amer. Jour. Sci. Jan. 1842, pl. ii. f. 42. *Echinella circularis* Grev., in Wernerian Society, vol. iv. p. 213. pl. viii. fig. 2., 1822; Scot. Crypt. Fl. vol. i. t. 35. *M. circulare* Ralfs, in Annals, vol. xii. p. 458. pl. xviii. f. 1.; Jenner, in Flora of Tunbridge Wells, p. 206.

Hab. Common throughout Great Britain, in pools, &c.

The frustules of this very beautiful production exhibit all the variety of sizes which characterise the different threads of the *Fragilariæ,* and this resulting from the same cause, viz. the lateral growth of the frustules. In the smaller and narrower frustules the end view is broadly clavate; in the larger and deeper frustules it is but slightly so, indeed almost linear. I have occasionally met with frustules which have been very perceptibly curved; this form possibly arising from the spiral disposition of the lamina in the more perfect specimens.

Colour yellowish brown, assuming a green tinge in drying.

2. MERIDION CONSTRICTUM *Ralfs.*

Plate XCVI. Figs. 7, 8, 9.

Char. Articulating surfaces *constricted at the broader end, striated; the* striæ *forming puncta in the front view.*

Meridion constrictum Ralfs, in Annals, vol. xiii. p. 458. pl. xiii. fig. 2.; Jenner, in Flora of Tunbridge Wells, p. 206.

"This is one of the additions to our Flora, for which I am indebted to Mr. Jenner, whose discoveries have added so largely to the Sussex *Cryptogamia*, and who is as indefatigable in his researches as he is accurate in his observations. Mr. Jenner finds it rather plentifully in the Cold Bath Spring, Tunbridge Wells, growing on *Fragilaria virescens*. I have received from him both dried and recent specimens. In the latter I find the frustules solitary or binate, the circles being entirely broken up before the specimens reached me; but Mr. Jenner informs me, that when gathered, they are united together so as nearly to form a circle. As, however, they are not arranged on a plane as in *Meridion circulare*, but stand nearly erect, somewhat like the staves of a tub which is broader above than below, when they are dry and fall down they necessarily separate, and gaps are produced in the circular outline. In the dried specimens I find some of the frustules arranged in a circle, which, however, exhibits the gaps already noticed, whilst others seem to be fasciculated.

"The front view cannot be distinguished from a frustule of *Meridion circulare*, with which it agrees in size and form, and also in having two conspicuous terminal puncta, and a series along the lateral margins. As in *Meridion circulare*, the lateral surfaces have a few distinct, strongly marked transverse striæ; but they differ from it most remarkably in the constriction below the apex." — *Ralfs.*

In the very deep frustules the constriction is almost lost.

Section ii.

Frond *stipitate.*

A. Frustules *wedge-shaped.*

75. GOMPHONEMA *Ag.*

Char. Frustules *cuneate, solitary or geminate, supported on a simple or branched and attached filiform stipes.*

Derivation. From *γομφος, a wedge,* and *νημα, a thread.*

The extremities of the frustules in the front view are punctated and truncated, but in the lateral aspect rounded or pointed; the frustules are for the most part striated laterally, the striæ being interrupted by a longitudinal pellucid line, in the centre of which is a depression often assuming the appearance of a foramen. The genus bears a close relation to the genera *Styllaria* and *Lichmophora*, the former genus differing only from *Gomphonema* in the frustules being invariably sessile, and the latter in having several frustules associated together at the end of each branch of the stipes, and forming a fan-like expansion.

The species of the genus *Gomphonema* are usually found in freshwater.

a. Frustules *in* lateral view *constricted below the apex, so as to appear urn-shaped.*

1. GOMPHONEMA GEMINATUM *Ag.*

Plate XCVIII. Fig. 1.

Char. Stipes *much branched, tufted.* Frustules *large, cuneate, often geminate, puncta at the end obsolete.* Lateral surfaces *urn-shaped, striated.* Striæ *radiating.*

Ag. Syst. p. 12.; Conspect. Diatom. p. 35.; Grev. Crypt. Fl. t. 244. f. 2.; Kütz. Synop. Diatom. in Linnæa, 1833, p. 569.; Harv. British Algæ, p. 207. *Gomph. ampullaceum* Grev., in Hook. Br. Fl. p. 410. *G. geminatum* Ralfs, in Annals, vol. xii. p. 460. pl. xviii. fig. 3.

Hab. On rocks in subalpine streams, Scotland: *Dr. Greville.* North of Ireland: *Mr. D. Moore.* Near Bandon, co. Cork: *Prof. G. J. Allman.* On dripping rocks, near a waterfall at Carnlough, co. Antrim: *Mr. W. Thompson.* Rapid streams at base of Cader Idris; and in the river above Dolgelly, North Wales: *Mr. Ralfs.*

"This plant forms large cushion-like tufts on the rocks in rapid streams. It is not in the least mucous, but is of a spongy texture, being composed of densely interwoven filaments. In a young state its colour is brownish, from the frustules covering the surface; but as these fall off it becomes whitish, and indeed not unlike a tuft of wool. Filaments repeatedly dichotomous; frustules much larger than in any of the following species, simple or binate, linear cuneate, without puncta at the upper end; portions of the lateral surfaces are frequently visible along the sides. Lateral surfaces urn-shaped, broader than the front, with numerous transverse dotted striæ. There is a central longitudinal pellucid line, slightly dilated at each end with a larger dilatation in the centre; the latter at first sight may be taken for a perforation, which it undoubtedly is not: from the central punctum the striæ are somewhat radiant: the pellucid line does not quite extend to the upper end."—*Ralfs.*

2. GOMPHONEMA TRUNCATUM *Ehr.*

Plate XCVIII. Fig. 2.

Char. Frustules *in* front view *cuneate, with two evident puncta at the upper end.* Lateral surfaces *urn-shaped, striated.*

G. truncatum and *G. paradoxum* Ehr., Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 88. 1833, p. 319. *G. pohliæforme* Kützing, in Linnæa, 1833, p. 569, 570. t. xvi. fig. 50. *G. truncatum* Ehr., Die Infus. p. 216. pl. xviii. fig. 1. *G. subramosum* Kütz., Synops. Diatom. p. 570. fig. 44. *G. pohliæforme* Ralfs, in Annals, vol. xii. p. 461. pl. xviii. f. 4. *G. capitatum*

Ehr., Die Infus.; Jenner, in Flora of Tunbridge Wells, p. 206.

Hab. On aquatic plants in pools and ditches, near Henfield: *Mr. Borrer.* Frequent in Sussex: *Mr. Jenner.* Cheshunt and neighbourhood: *A. H. H.* Oswestry: *Rev. T. Salwey.* Ilfracombe; Swansea; Dolgelly and Bangor, North Wales: *Mr. Ralfs.*

A very distinct little species. The degree of constriction of the neck varies considerably in different specimens; and this circumstance doubtless led to the institution on the part of Ehrenberg of the *Gomphonema capitatum*, which is assuredly but a state of *G. truncatum*.

3. Gomphonema acuminatum *Ehr.*

Plate XCIX. Fig. 1.

Char. Frustules *in* front view *cuneate and truncate.* Lateral surfaces *constricted, acuminate, striated.*

G. minutum Ag., Conspect. Diatom. 1832, p. 34.; Grev. in Hook. Br. Flor. vol. ii. p. 410. *Gomph. acuminatum*, Abhandl. der Akademie d. Wissensch. zu Berlin, 1831, p. 86.; Bericht. der Akademie d. Wissensch. zu Berlin, 1836, p. 53., 1837, p. 44.; Die Infusor. p. 217. t. xviii. fig. 4. *G. minutum* Ralfs, in Annals, vol. xii. p. 462. pl. xviii. f. 5.; Jenner, in Flora of Tunbridge Wells, p. 206.

Hab. Sussex: *Mr. Jenner.* Cheshunt, &c.: *A. H. H.* Barmouth: *Rev. T. Salwey.* Trengwainton ponds, near Penzance, and pond on Towednack Moor, near St. Ives; Dolgelly: *Mr. Ralfs.*

The degree of constriction and acumination of the frustules would appear to be subject to very considerable variation. As the species was published at nearly the same period, by both Agardh and Ehrenberg, and apparently first by Ehrenberg, I have retained the name of the latter which is infinitely the more appropriate.

b. Lateral surfaces *not constricted below the apex.*

4. GOMPHONEMA CRISTATUM *Ralfs.*

Plate C. Fig. 1.

Char. Frustules *crested, not constricted below the apex, striated laterally.*

Gomphonema cristatum Ralfs, in Annals, vol. xii. p. 463. pl. xviii. fig. 6.; Jenner, in loc. cit. p. 206.

Hab. On *Conferva glomerata* in a stream near Shoreham, Kent, Dec. 1842. Farnham, Surrey: *Mr. Jenner.*

The only species with which this beautiful *Gomphonema* could be confounded is *G. acuminatum*, from which it differs in being altogether a smaller plant, and in the absence of the constriction below the apex.

For its discovery naturalists are indebted to Mr. Jenner.

5. GOMPHONEMA DICHOTOMUM *Kütz.*

Plate XCIX. Fig. 2.

Char. Frustules *linear, cuneate in* front view, *with very minute terminal puncta.* Lateral surfaces *lanceolate, faintly striated.*

Kütz. Synops. Diatom. p. 569. fig. 48.; Ralfs, in Annals, vol. xii. p. 463. pl. xviii. fig. 7. *Gomph. gracile* Ehr., Die Infus. p. 217. t. 18. fig. 3.; Pritch. Infus. p. 227. *G. angustum?* Ag., 1831.

Hab. Trengwainton ponds, near Penzance: *Mr. Ralfs.*

The frustules of this species somewhat resemble those of *Gomphonema Berkeleyi*, but they are more elongated, narrower, often nearly linear, and their lateral surface lanceolate, and not clavate.

6. GOMPHONEMA BERKELEYI *Grev.*

Plate C. Fig. 2.

Char. Frond *forming large mucous masses.* Stipes *branched,*

entangled. Frustules *short, triangular, with two conspicuous puncta at the end.* Lateral surfaces *obovate or sub-clavate.*

β Frustules *scattered, more firmly attached to the stipes, which is more evident.*

Grev. in Hook. Br. Fl. vol. ii. p. 409.; Harv. Br. Alg. p. 207. *Gomph. ? olivacea* Ehr., Die Infus. 218. t. 18. f. 9.; Pritch. Infus. p. 228. *Exilaria minutissima* Berk., Br. Alg. p. 22. t. 7. f. 1. *Miridion vernale* Ag., Consp. Diatom. p. 556. f. 31. *Gomph. geminatum* Kütz., Alg. Aq. dulc. No. 13. *Gomph. Leiblini* Kütz., Synop. Diatom. p. 568. fig. 46.

Hab. On stones, &c., in freshwater spring, King's Cliff, Northamptonshire: *Rev. M. J. Berkeley.* Henfield, Sussex: *Mr. Borrer.* Mayfield, Sussex: *Mr. Jenner.* Yarmouth: *Mr. Dawson Turner.* River Severn, near Shrewsbury: *Mr. Leighton.* Cheshunt, Herts, and River Lea: *A. H. H.* At the base of Bandon Mountains: *Mr. Andrews.* — β. Duddingston Loch: *Dr. Greville.*

The stipes in the species in its ordinary state, owing to its being imbedded in a mucous matrix, is often with difficulty discernible. The frustules approach rather closely to those of *Gomph. dichotomum;* than which, however, they are shorter, broader, and more decidedly cuneate.

7. Gomphonema minutissimum *Ag.*

Plate C. Fig. 3.

Char. Frustules *curved, striated; terminal puncta well marked.* Lateral surfaces *clavate, striated.*

Kütz. Syn. Diatom. p. 567. fig. 43.; Ehr. Die Infus. p. 219. t. 18. fig. 5.; Pritch. Infus. p. 228. *Gomph. curvatum* Kütz., Syn. Diatom. p. 567. f. 51.; Kütz. Aq. dulc. No. 76.

Hab. Shrewsbury: *Mr. Leighton.* Shoreham, Kent:

Mr. Jenner. Cheshunt: *A. H. H.* Near Dublin: *Prof. G. J. Allman.* Swansea: *Mr. Ralfs.*

"This species differs from all the foregoing in its curved frustules, in having a notch on one only of the lateral margins and two striæ passing down the frustule and connecting the upper and lower puncta." — *Ralfs.*

76. PODOSPHENIA.

Char. Frustules *wedge-shaped, never constricted.* Stipes *none, or very short.*

Derivation. From *πους, a foot,* and *σφην, a wedge.*

This genus differs from *Gomphonema* in the absence of a regular and branched stipes. In their young condition the frustules are attached in the same manner as those of the *Exilariæ.*

1. PODOSPHENIA? OCULATUM.

Plate C. Fig. 9.

Char. Frustules *large, in* front view *wedge-shaped;* laterally *ovoid, striated.* Striæ *short.*

Gomphonema oculatum Kützing, in Linnæa, p. 568. f. 45. *G. rotundatum* Ehr., xviii. f. 7.

Hab. By the side of a rapid stream, parasitic on *Lyngbya zonata,* at Corham, near Bristol: *Mr. Thwaites.*

A very beautiful species, for an examination of which in a recent state I am indebted to Mr. Thwaites, its first and only discoverer in this country.

B. Frustules *semi-elliptical.*

77. COCCONEMA.

Char. Frustules *stipitate, semi-elliptical, with a longitudinal furrow, striated.*

Derivation. From *κοκκος, a grain,* and *νημα, a thread.*

The frustules in this genus may be compared to a grain of wheat in form.

1. Cocconema lanceolatum *Ehr.*

Plate CI. Fig. 1.

Char. Frustules *large, semi-lanceolate, straight, obtuse.*

Gomphonema lanceolatum Agardh, Conspect. Crit. Diatom. 1831, p. 34. *Gomphonema* (*Paltonophora*) *lanceolatum* Kütz., in Linnæa, 1833, p. 38.; Jenner, in Flora of Tunbridge Wells. *Cocconema lanceolatum* Ehr., Die Infus. p. 224. pl. xix. fig. 6.

Hab. Waterfall at Hill Park, Westerham, and at Shoreham, Kent; Parham, near Pulborough, &c.: *Mr. Jenner.* Cheshunt: *A. H. H.*

This is a very fine and distinct species.

2. Cocconema cymbiforme *Ehr.*

Plate CI. Fig. 2.

Char. Frustules *slightly curved, narrow, attenuated, subacute.*

Frustulia cymbiformis Kütz., in Linnæa, 1833, p. 540. t. 15. fig. 9. *Cocconema cymbiforme* Ehr., Die Infus. p. 225. pl. xix. f. 8.; Jenner, in Fl. of Tunbridge Wells.

Hab. New River reservoir, Cheshunt: *A. H. H.*

This species might readily be confounded with the previous one, from which it is to be distinguished by its smaller, narrower, more attenuated and somewhat curved frustules.

3. Cocconema cistula *Ehr.*

Plate CI. Fig. 3.

Char. Frustules *crescentic, ventricose, obtuse, often in pairs.*

Cocconema cistula Ehr., Die Infus. p. 224. pl. xix. f. 7.; Jenner, in Fl. of Tunbridge Wells. *Cymbella copulata* Breb. and Godey. *N. geminata?* Turp. (1828).

Hab. Frequent in Sussex: *Mr. Jenner.* Cheshunt: *A. H. H.*

The frustules in this species are shorter than in those previously described, more ventricose and obtuse. In *C. lanceolatum* the frustules are straight, in *C. cymbiforme* but slightly curved, while in *C. cistula* they are considerably so.

4. COCCONEMA VENTRICOSA? *Hass.*

Plate CI. Fig. 4.

Char. Frustules *small, straight, ventricose, obtuse.*

Cocconema? gibbum Ehr., Die Infus. p. 225. pl. xix. f. 9.; Jenner, in Flora of Tunbridge Wells. *Cymbella ventricosa* Ag.? Flor. Bot. Zeit.; Breb. and Godey.

Hab. Cheshunt: *A. H. H.* Waterfall at Harrison rocks: *Mr. Jenner.*

This is the smallest species of the genus which has hitherto been described. From *Cocconema phœnicenteron*, with which it might be confounded, it differs in size and in the frustules not being curved.

78. CYMBELLA *Hass.*

Char. Frustules *cymbiform, striated, sulcated, not stipitate.*

Derivation. The diminutive of *cymba*, a boat; in allusion to the form of the frustules.

This genus differs from *Cocconema* only in the frustules not being stipitate as they are in that genus. Although not stipitate, the frustules frequently are attached in the entire length of their flat surface to other *Algæ*, often to *Clodophora crispata*. The *Cymbella* of Agardh embraces species belonging to several distinct genera, and not one of those here described under the name of *Cymbella*. The following are

species of the genus *Cymbella*: *N. amphora* Ehr., *N. lineolata* Ehr., and *N. Westermanni*.

1. Cymbella zebra *Hass.*

Plate C. Fig. 8.

Char. Frustules *in* side view *semi-lanceolate, truncate; in* front aspect *elongated, quadrangular, with straight sides.* Striæ *distant, strongly marked, double.*

Navicula zebra, Abhandl. der Akademie d. Wissensch. zu Berlin, p. 262.; Bericht. der Akademie d. Wissensch. zu Berlin, 1837, p. 53. *Eunotia zebra* Ehr., Die Infus. p. 191. pl. xiv. fig. 7. pl. xxi. f. 19.

Hab. Cheshunt: *A. H. H.* On the moist conglomerate sandstone cones near Cushendall, co. Antrim: *Mr. Moore.*

This fine species approaches rather closely to the following, from which it differs however in two respects; in the striæ, which in *Eunotia zebra* are less numerous than in *E. turgida*, and in the form of the frustule, which in the front view is not attenuated at the extremities as it is in that species.

2. Cymbella turgida *Hass.*

Plate C. Fig. 7.

Char. Frustules *semi-lanceolate, truncate at either extremity in* side view; *in* lateral aspect *narrower towards either end than in the centre.*

Navicula turgida, Abhandl. der Akademie d. Wissensch. zu Berlin, 1830. *Eunotia turgida*, Bericht. der Akademie d. Wissensch. zu Berlin, 1837, p. 45.; Die Infus. p. 190. t. xiv. fig. 5.

Hab. Storrington Common: *Mr. Jenner.*

This species needs only to be contrasted with *Cymbella zebra*, from which it differs in the two particulars indicated in the description of that species, viz. in its finer and closer

striæ, and in the frustules being attenuated in the front view towards either extremity.

3. CYMBELLA? ARCUS *Hass.*

Plate C. Fig. 6.

Char. Frustules *smooth. In* front view *contracted towards either end; in* lateral aspect *curved, attenuated, with a projection in the centre of the concave margin.*

Navicula arcus, in Wiegmann's Archiv. fur Naturg. 1836, p. 243, 244.; Die Infus. p. 182. t. xxi. fig. 10.

Through this species the genera *Cymbella* and *Navicula* would appear to be united, it agreeing with the first in the semilunar and curved form of the frustule in its lateral view, and with the latter in its attenuation in its anterior aspect.

C. *Form of* frustules *various.*

79. NAVICULA *Bory.*

Char. Frustules *straight. In* front view *usually somewhat attenuated towards either end, extremities generally truncate; in* lateral aspect *boat-shaped, extremities often acute.*

Derivation. From *navicula,* a little boat.

This genus, as limited to those species, which the above definition is intended to include, would appear to be an exceedingly natural one.

a. Frustules *without transverse striæ.*

1. NAVICULA PHŒNICENTERON *Ehr.*

Plate CII. Fig. 9.

Char. Frustules *elongated, smooth, large. In* front view *attenuated towards either end; in* lateral aspect *extremities lanceolate.*

Navicula phœnicenteron Ehr., Die Infus. p. 175. t. xiii. fig. 1. *β*.

Hab. Cheshunt: *A. H. H.* — Var. *β*. Gardener Street: *Mr. Jenner.*

It is possible that the variety *β* of Ehrenberg, which is that here described under the name of *N. phœnicenteron*, is really distinct. The frustule is not transversely striated, but several longitudinal lines may frequently be noticed running along the centre of each.

2. Navicula palea *Hass.*

Plate CII. Fig. 10.

Char. Frustules *small, smooth. In* front view *attenuated, with truncate extremities; in* side aspect *lanceolate.*

Navicula gracilis Ehr., Die Infus. p. 176. t. xiii. fig. 2. *Frustulia gracilis* Jenner, in Flora of Tunbridge Wells, p. 204. *Cymbella avenacea* Breb. et Godey.

Hab. Cheshunt: *A. H. H.* In the great bog near Forest Row; bogs at Fisher's Castle, &c.: *Mr. Jenner.*

This species resembles *N. phœnicenteron* in miniature.

3. Navicula amphisbæna *Bory.*

Plate CII. Fig. 5.

Char. Frustules *elongated. In* front view *quadrangular, with straight sides; in* lateral aspect *oval, prolonged at each end into a blunt process.*

Navicula amphisbœna Bory, Encycl. Méth. 1824. *Navicula amphisbœna* Turpin, Diction. des Sc. Nat. 1828. *N. ventricosa*, Abhandl. der Akademie d. Wissensch. zu Berlin, 1830, p. 67. *N. amphisbœna*, Abhandl. &c. 1833 (1832), p. 254. *Frustulia cuspidata* Kütz., Linnæa, 1833, p. 549. t. xiv. fig. 26. *N. amphisbœna*, Die Infus. p. 178. t. xiii. f. 7. *Cymbella appendiculata* Godey et Breb.

Hab. Cheshunt: *A. H. H.* Aberdeen: *Dr. Dickie.*

A very well marked species.

4. Navicula platystoma *Ehr.*

Plate CII. Fig. 6.

Char. Frustules *elongated, quadrangular, with straight sides, rostrated at each end.*

Hab. Cheshunt: *A. H. H.*

Die Infus. p. 178. t. xiii. fig. 8.

A distinct and not uncommon species.

b. Frustules *striated.*

5. Navicula nodosa *Ehr.*

Plate CII. Fig. 7.

Char. Frustules *small, in side view thrice undulated, rostrated at each extremity.*

Die Infus. t. xiii. fig. 9. *Frustulia nodosa?* Jenner, in Fl. of Tunbridge Wells, p. 204.

Hab. On Ashdown Forest, near Forest Row, between Gardener Street and Hailsham, &c.: *Mr. Jenner.*

Mr. Jenner remarks that his specimens agree with Ehrenberg's description and figures in every respect save that the frustules were striated. It is probable that Ehrenberg overlooked the striæ, and that these are always present.

6. Navicula inæqualis *Ehr.*

Plate CII. Fig. 13.

Char. Frustules *in* front view *attenuated, towards each end truncate; in* side aspect *unequal.*

Navicula inæqualis, Bericht. der Akademie d. Wissensch. zu Berlin, 1836, p. 53.; Die Infus. p. 184. t. xiii. f. 18.

Hab. Gardener Street: *Mr. Jenner.*

Through this and the following species the genus *Navicula* seems to pass into that of *Cymbella*, in which genus indeed the striated *Navicula* would not be very improperly placed.

7. Navicula gibba *Ehr.*

Plate CII. Fig. 4.

Char. Frustules *in* lateral view *straight, narrow, inflated; near the* centre *gibbous.*

Navicula gibba, N. unciata, Abhandl. der Akademie d. Wissensch. zu Berlin, 1830, p. 64, 65. 68. 1831, p. 80. *Frustulia incrassata* Kützing, Linnæa, 1833, p. 545. t. xiii. fig. 17. *Navicula gibba,* Die Infus. p. 184. t. xiii. f. 19.; Jenner, in Fl. of Tunbridge Wells, p. 204.

Hab. Cheshunt: *A. H. H.* Ashdown Forest: Jack's Wood Spring; Chiltington Common, near Pulborough, &c.: *Mr. Jenner.*

8. Navicula lanceolata *Ehr.*

Plate CII. Fig. 14.

Char. Frustules *lanceolate, extremities subacute.*

Frustulia lanceolata Kütz., in Linnæa, 1833, p. 14. t. xiii. f. 13. *Navicula lanceolata* Ehr., Die Infus. p. 185. t. xiii. fig. 21.

Hab. Sussex: *Mr. Jenner.*

A well-marked little species.

80. EXILARIA *Grev.*

Char. Frustules *elongated, at first attached by a sessile and undivided stipes, subsequently free, radiated, single, or binate.* Junction surfaces *frequently striated.*

Derivation. From *exilio,* to issue forth; in allusion to the radiate disposition of the frustules.

This genus bears a slight resemblance to *Gomphonema*, the frustules being attached in the young state of the species; they are not, however, triangular, as in the genus *Gomphonema*.

1. Exilaria capitata.

Plate XCVII. Fig. 1.

Char. Frustules *large.* *In* front view *truncate at the ends; in* side view *dilated at both extremities into an obtusely pointed head; striated.*

Ehr. Die Infus. p. 211. pl. xxi. fig. 28.

This fine and beautiful species I found growing in immense quantity in some ditches running parallel to the Barge river near Cheshunt marshes. A few frustules of it have also, I believe, been found by Mr. Ralfs. The frustules in the front view are not to be distinguished from those of *Exilaria ulna;* the side view of *E. capitata* is, however, so distinct, that it would be impossible to confound it with that species.

2. Exilaria Ulna.

Plate XCVII. Fig. 2.

Char. Frustules *large in the fully developed state.* *In* front view *slightly dilated at the extremities, and truncate; in* lateral aspect *striated, extremities pointed.*

Leuwenhoek's Philosophical Transactions, 1703 (1702), fig. 8. L. K. *Bacillaria ulna* Nitzsch, Beiträge zur Infusorienkunde, 1817, p. 99. t. 5. *Bacillaria communis* Bory, in Dict. Class. 1822. *Frustulia obtusa* and *F. ulna* Agardh, Consp. Crit. Diatom. *Echinella fasciculata β truncata* Greville, 1823; Scot. Crypt. Fl. 1. t. xvi. *Exilaria fasciculata* Greville, 1827; Scot. Crypt. Fl. v. f. 291 b. *E. truncata* Kütz., in Linnæa, 1833, p. 560. *Frustulia Ulna* Harv., in Manual, p. 204.

Synedra Ulna Ehr., Infus. p. 211. pl. xvii. fig. 1.; *E. Ulna* Jenner, in Flora of Tunbridge Wells, p. 204.

Hab. Common in ponds and ditches throughout Britain.

An exceedingly distinct species, not likely to be confounded with any other. The extremities of the frustules would appear to undergo the same change as has been observed in those of *Diatoma elongatum*, and to become somewhat dilated.

3. Exilaria fasciculata *Kütz.*

Plate XCVII. Fig. 3.

Char. Frustules *small. In* front view *alternated at either end; in* side view *extremities acute.*

Exilaria Vaucheriæ, E. fasciculata, in part, Kütz., in Linnæa, 1833, p. 560, 561. t. xv. p. 38. 40. *Synedra fasciculata* Ehr., Infus. p. 212. t. xvii. fig. 2. *Exilaria truncata* Harv., in Manual, p. 204. *Diatoma truncatum* Grev., in Hook. Br. Fl. p. 407.

Hab. Common in ditches, &c.

This is a very distinct little species: the frustules are often in pairs, and owing to these being frequently but imperfectly separated from each other, a curved or fan-shaped lamina is produced.

4. Exilaria lunaris.

Plate XCVII. Fig. 4.

Char. Frustules *curved, small, slender, converging at the extremities.*

Synedra lunaris Ehr., Die Infus. p. 212. pl. xvii. fig. 4. *Exilaria lunaria* Jenner, in Flora of Tunbridge Wells, p. 204.

A very distinct and pretty little species.

81. GYROSIGMA *Hass.*

Char. Frustules *straight in* front view; *curved in the form of the letter* S *in* lateral aspect; *longitudinally striated, with a central depression.*

Derivation. From *γυρος, a curve,* and *σιγμα, the letter* S; in allusion to the form of the frustules.

1. GYROSIGMA HIPPOCAMPA *Hass.*

Plate CII. Fig. 11.

Char. Frustules *in* front view *attenuated towards each extremity; in* side aspect *lanceolate, curved, longitudinally striated.*

Nav. hippocampus Ehr., Die Infus. p. 180. t. xiii. f. 11.; *Frustulia hippocampus* Jenner, in Fl. of Tunbridge Wells, p 204.

Hab. Cheshunt: *A. H. H.* Olford and Shoreham, Kent: *Mr. Jenner.*

In the same genus with this species should be placed the *Navicula sigma, N. scalprum,* and *N. curvula* of Ehrenberg.*

82. NITZSCHIA *Hass.*

Char. Frustules *curved in* front *view in the form of the letter* S; *in* lateral *aspect straight, transversely striated, and without a longitudinal furrow and central depression.*

Derivation. Named in memory of *M. Nitzsch.*

The single species upon which this genus is founded accords with *Exilaria* in all its characters, save in the segmoidal curvatures of the frustules.

1. NITZSCHIA ELONGATA *Hass.*

Plate CII. Fig. 12.

Char. Frustules *linear, lengthened, with truncate extremities in*

* The *Sigmatella* of Kützing, the construction of which term is somewhat objectionable, is synonymous with *Gyrosigma.*

front view; *straight, attenuated at either end in* lateral aspect.

Bacillaria sigmoidea Nitzsch, Beiträge z. Infusorienkunde, 1817 (1816), p. 104. *Cymbella sigmoidea* Agardh, Consp. Crit. Diatom. 1830, p. 11. *Frustulia Nitzschii* Kütz., Linnæa, 1833, p. 554. t. xiv. fig. 33. *Navicula sigmoidea* Ehr., Die Infus. p. 182. t. xiii. f. 15. t. xxi. f. 11.

A well-marked species, which I conceive to be generically estranged from *Gyrosigma hippocampa* by the difference in the curvature of the frustule, the arrangement of the striæ, and the absence of the longitudinal furrow and central depression.

83. SPHINCTOCYSTIS *Hass.*

Char. Frustules *contracted in the centre; longitudinal furrow and central depression absent?*

Derivation. From σφιγκτος, *constricted,* and κυστις, *a cell.*

1. Sphinctocystis librilis *Hass.*

Plate CII. Fig. 3.

Char. Frustules *transversely striated, elongated. In* front view *quadrangular, with straight sides and truncate extremities; in* lateral aspect *constricted in the centre with obtuse ends.*

Navicula librilis Abhandl. d. Akademie d. Wissensch. zu Berlin, 1831, p. 81. 1833, p. 267. note. *Frustulia quinquepunctata* Kützing, Linnæa, 1833, p. 554. t. xiv. f. 28.; Die Infus. p. 185. t. xiii. f. 21. *Frustulia librilis* Jenner, in Fl. of Tunbridge Wells, p. 204.

Hab. Cheshunt: *A. H. H.* Aberdeen: *Dr. Dickie.* Warburton, Lewes, &c.: *Mr. Jenner.*

A very curious species, which, on account of the central constriction and absence of the longitudinal furrow and central depression, I have ventured to make the type of a distinct genus.

84. AULACOCYSTIS *Hass.*

Char. Frustules *produced, longitudinally sulcated.*

Derivation. From *αυλαξ, a groove,* and *κυστις, a cell.*

1. AULACOCYSTIS PELLUCIDA *Hass.*

Plate CII. Fig. 8.

Char. Frustules *elongated, narrow, attenuated at each extremity.*

Navicula? pellucida, Die Infus. p. 176. t. xiii. fig. 3. *Frustulia pellucida* Kütz., in Linnæa, 1833, p. 543. t. xiii. fig. 11.; Jenner, in Fl. of Tunbridge Wells, p. 204.

Hab. Ashdown Forest, and at Shoreham, Kent; between Tunbridge Wells and the High Rocks: *Mr. Jenner.*

There can be no doubt of the propriety of separating this species from the genus *Navicula* of Ehrenberg.

85. FRUSTULIA *Kütz.*

Char. Frustules *elongated, quadrangular, with two longitudinal grooves and two central depressions.*

Derivation. From *frustulum,* a small fragment.

I must confess that I do not exactly understand the structure of the single species which I propose to retain in the genus *Frustulia.* It is possible that to this genus should be referred those species of *Navicula* which have striated frustules; and, if not to this genus, possibly those species should be regarded as *Cymbellæ.*

1. FRUSTULIA? VIRIDIS *Kütz.*

Plate CII. Fig. 2.

Char. Frustules *large, elongated. In* front view *quadrangular, with straight sides and truncate extremities;* laterally *slightly inflated in the centre, with rounded ends.*

Frustulia viridis Kûtzing, Linnæa, 1833, p. 551. *Navicula viridis* Ehr., Die Infus. p. 182. t. xiii. f. 16. t. xxi. fig. 12. *Frustulia viridis* Jenner, in Fl. of Tunbridge Wells, p. 203. *Nav. biceps?* Bory, Encyc. Méth. 11824.

Hab. Frequent in Sussex: *Mr. Jenner.* Cheshunt: *A. H. H.* Aberdeen: *Dr. Dickie.* Ireland: *Mr. Moore.*

This is one of the finest and most beautiful of all the *Diatomaceæ.* In young specimens the frustules are not at all or scarcely inflated in the centre.

86. SURIRELLA *Turp.*

Char. Frustules *large, solitary, quadrangular;* angles *produced, striated.*

Derivation. Named in honour of *Dr. Suriray.*

This seems to be a well-marked genus. To it should be referred, in addition to the two species described below, *Navicula? splendida, N.? undulata, N.? constricta,* which would stand thus: *Surirella splendida, S. constricta,* and *S. undulata.* The two latter species differ from all the others in the transverse striæ being in single and not double series, that is, they pass entirely across the frustule. This genus seems to have been indicated by Ehrenberg.

1. SURIRELLA BISERIATA *Breb.*

Plate CII. Fig. 1.

Char. Frustules *in* front view *quadrangular, about three times as long as broad, with straight sides and truncate extremities; in* lateral aspect *oval, with pointed ends.*

Navicula? bifrons Ehr., Die Infus. p. 186. t. xiv. fig. 2. *Surirella biseriata* Jenner, in Fl. of Tunbridge Wells.

Hab. Ashdown Forest, Piltdown Common, Broadwater Forest, and Warbleton: *Mr. Jenner.*

2. SURIRELLA JENNERI *Hass.*

Plate CII. Fig. 15.

Char. Frustules *in* front view *obtuse at each extremity, and with striæ in double series;* end view *quadrangular, each angle being prolonged into a thin plate.*

Surirella bifrons Jenner, loc. cit. p. 204.

Hab. Warbleton: *Mr. Jenner.*

A very distinct and beautiful production, having no relation with the *N. bifrons* of Ehrenberg.

87. ENCYONEMA *Kütz.*

Char. Frustules *cymbiform, enclosed within a membrane.*

Derivation. From εγκυος, *full,* and νημα, *a thread.*

1. ENCYONEMA PROSTRATUM *Kütz.*

Plate C. Fig. 10.

Char. Frustules *striated, straight, gibbous, small, enclosed within a transparent membranous tube.*

Encyonema prostratum Kütz., Die Kreselschaligen, &c. p. 82. t. 25. f. 7. *Encyonema paradoxum* Kütz., Synops. Diatom. *Monema prostratum* Berk., Glean. of Br. Algæ. *Schizonema? prostratum* Grev., in Hook. Br. Fl., p. 414.; Harv. in Manual, p. 214. *Encyonema prostratum* Jenner, in Fl. of Tunbridge Wells, p. 206.

Hab. On the boards of a sluice forming a thin, brown mucous stratum: *Rev. J. M. Berkeley.* On the boards of a sluice on Cheshunt Marshes: *A. H. H.* Brambletye, near Forest Row, and in the stream which parts Sussex and Kent, between Bodiam and Sandhurst.

A very singular and beautiful production, coming near to *Schizonema.*

SUPPLEMENT.

ZYGNEMA INSIGNE *Hass.*

Plate CIII. Figs. 1, 2.

Char. Filaments *of considerable size.* Cells *four or five times as long as broad, inverted.* Spires *three, lax, indistinct.* Sporangia *oval, acute, producing considerable inflation of the cells in which they are placed.*

Hab. Ponds at Wadhurst, near Tunbridge Wells, and Iden, near Rye: *Mr. Jenner.*

This fine species is rendered particularly interesting from the circumstance of its being the only *Zygnema* with *three spires* having inverted cells, all other species thus constructed which have hitherto been discovered possessing, with but one exception, in which there are two threads, only a single spire.

The filaments are about equal in size to those of *Zygnema rivulare,* from which it is at once distinguished by its inverted cells.

The credit of the discovery of this species is entirely due to Mr. Jenner.

LYNGBYA FUSCO-PURPUREA *Hass.*

Plate VIII. Figs. 1, 2.

Char. Filaments *of considerable size, forming a brownish green or purple stratum, glossy.* Endochrome *at first homogeneous, subsequently granular.* Granules *few, about five in each cell.*

Grev. Alg. Brit. p. 177.; Hook. Br. Fl. vol. ii. p. 316.; Wyatt, Alg. Danm. No. 167. *Conf. fusco-purpurea* Dillw. t. 92.; E. Bot. t. 255. *Conf. atro-purpurea* Dillw. t. 103.; E. Bot. t. 2085. *Bangia atro-purpurea* Harv. p. 172.

Hab. Grand Canal, near Dublin: *W. H. Harvey.*

Between this production and *Lyngbya zonata* there is a great structural resemblance, and assuredly the two species do not differ generically from each other.

The interesting discovery of this being a freshwater production was made by Mr. Harvey, who states that the locality in which he gathered it had no communication with the sea.

COCCOCHLORIS CYSTIFERA *Hass.*

Plate CIII. Fig. 3.

Char. Granules *rather large, mostly oval, contained in mucous cysts, each cyst being occupied with either one or two, but sometimes, four granules.*

Hab. Near Bristol: *Mr. Thwaites.*

This and the two following species are particularly interesting, from the fact of their exhibiting a cysted structure, whereby a close relation is manifested in these species to *Hæmatococcus*, and which structure moreover it is probable does in reality belong to all the species of the genus *Coccochloris*, but which escapes detection from the exceeding delicacy of the organisation of many of the species.

COCCOCHLORIS VARIABILIS *Hass.*

Plate CIII. Fig. 4.

Char. Granules *in the dried condition not having any regular form, rather small.* Cysts *somewhat large, containing one, two, or four granules, mostly spherical.*

Hab. On thatch, Northiam: *Mr. Jenner.*

It is only in the exterior and more consistent portions of the frond that the cysts are clearly visible; they are usually spherical, but occasionally elongated and pointed at each end, the contained granules being likewise elongated, and small, almost abortive.

COCCOCHLORIS OBSCURA *Hass.*

Plate CIII. Fig. 5.

Char. Granules *small and circular.* Cysts *also small.*

Hab. Limestone rocks, co. Antrim: *Mr. Moore.*

The granules and cysts in this species are much smaller than in *Coccochloris cystifera,* and not unfrequently a little difficulty is perceived in detecting them.

"The Observations which have been made in these latter Times by the help of the *Microscope* since we had the Use and Improvement of it, discover a vast Difference between Natural and Artificial Things. Whatever is Natural, beheld through that, appears exquisitely form'd and adorn'd with all imaginable Elegancy and Beauty. There are such inimitable Glidings in the smallest Seeds of Plants, but especially in the Parts of Animals, in the Head or Eye, of a small Fly; such Accuracy, Order, and Symmetry in the Frame of the utmost minute Creatures, a *Louse,* for Example, or a *Mite,* as no Man were able to conceive without seeing of them. Whereas the most curious Works of Art, the sharpest and finest Needle, doth appear as a blunt rough Bar of Iron, coming from the Furnace, or the Forge. The most accurate Engravings, or Embossments, seem such rude, bungling, and deformed Work, as if they had been done with a Mattock, or Trowel; so vast a difference is there betwixt the Skill of Nature, and the Rudeness and Imperfection of Art. I might add, that the Works of Nature, the better Lights and Glasses you use, the more clearer and exactly form'd they appear, whereas the Effects of humane Art, the more curiously they are view'd and examin'd, the more of Deformity they discover." —*Ray.*

CONCLUSION.

I HAVE at length brought to a conclusion a work which for a considerable period has occupied much of my time and many of my thoughts. The feelings which have attended its progress have been various: frequently, as on the discovery of new species or facts, or the elucidation of some difficult point, those of pleasure and satisfaction have prevailed; occasionally the opposite ones of doubt, and even despair, have been predominant, as when I could not satisfactorily see my way through difficulties; these feelings, however, poignant as they were while they lasted, were, I am happy to say, but of short duration. Next day the task was usually resumed, and all the doubt and perplexities vanished before renewed examination.

Those who follow after me in the investigation of this department of natural science, still so rich in the discoveries which it yields to deserving perseverance, while they will to an extent scarcely inferior participate in the feelings of satisfaction and delight which I have expressed, will, it is hoped, share less those of an opposite character, now that the way is opened out, and that a clearer view of the subject may be obtained.

It was my intention to have made this History of the British Freshwater *Algæ* answer more closely to the title of a history than in its present form it does, and that it should have contained a chapter devoted to a historical consideration of the subject; this, although a difficult undertaking, would have been a most grateful one, for it would have afforded an opportunity of mentioning in the terms of eulogy which they

deserve the names of all those who have made the Freshwater *Algæ* the object of their study. I had intended also to have entered upon the consideration of the subject of classification, and to have remarked on those which have hitherto been proposed. I have been prevented from fulfilling these intentions by the fact that this work has already greatly exceeded the limits originally proposed for it. Should it be destined, however, to reach a second edition, chapters devoted to the consideration of these two questions might, by the adoption of a smaller type, be inserted with advantage. So much for the omissions from the work. I would now refer to a superfluity, and beg the Reader's indulgence for what I fear, without explanation, might be deemed an unnecessary intrusion on his notice, the attachment of the writer's name either to each new species or to those which for the first time have been referred to other genera. This was done under the impression that the practice was usual and customary.

That much still remains to be effected ere our knowledge of the Freshwater *Algæ* shall be in any thing like a complete state is evident from the number of species which for the first time are introduced in this work. So numerous are these, and so closely do many of them approach each other, that there are some, I fear, and especially such as have not made the *Algæ* their study, and who therefore are scarcely in a position to declare what amount of difference is of specific value, who will be ready to assert, that the species have been multiplied on insufficient grounds. Let such pause ere they advance such an injurious assertion, which, like all assertions, it is an easy matter to make, but more difficult to substantiate; let them first bestow upon those species the care, labour, and anxiety of their founder, and then their opinion will be rendered valuable, and injustice be inflicted on no party.

That superficial observers should arrive at the conclusion that nearly allied species are states of one and the same production is not so surprising, when we consider that the characters which distinguish species amongst the *Algæ* are frequently not very obvious or prominent, and since even men

of acknowledged skill and powers of observation have even fallen into the error of asserting that a number of distinct species are conditions of one and the same plant. Thus M. G. Thuret, whose papers on the locomotive organs of the spores of the *Algæ* are the most interesting and important of any which have ever appeared on the *Algæ*, has committed this mistake in reference to the *Vaucheriæ*, declaring that all the species are states of one and the same production, and comprising them all under the name of *Vaucheria Ungeri:* for a refutation of this position, see the figures of the species of this genus contained in the present work. Other observers, again, even go further than this, not allowing the *Vaucheriæ* to rank as species at all, but stating that they are merely stages in the growth of mosses. Statements of this transformation of *Algæ* into mosses, &c., are wholly without foundation, and wholly undeserving of credit.

The end is drawing near. How strongly are we mortals the creatures of habit and association! with what reluctance do we quit a place, a companion, or a pursuit with which we have been long connected, and it may be not altogether agreeably so! The prisoner of Chillon felt regret at quitting the prison of which for so many years he had been the solitary inhabitant: each of us can call to mind the pain which we have experienced in leaving a companion with whom we have been long associated, even though that companion may not have been really esteemed by us; and I must confess that I cannot banish some feeling of regret at the conclusion of this undertaking, which has for so long a time interwoven itself with my thoughts, notwithstanding that there are several considerations which render the completion of the task a subject of congratulation.

Although in a few days I shall cease to be occupied with this work, the interest with which the subject of which it treats has inspired me will not have ceased. In the fact that I have devoted so much time to its consideration there is no regret: I am still willing to devote more to it; and I shall gladly at all times avail myself of the correspondence of all or any who may take an interest in the *Algæ*, and will

favour me with their communications, and assist them in the determination of the productions of the localities in which they reside.

Apart from the interest attached to the examination of the individual species, there is a source of pleasure in the additional interest which is imparted to our rambles: each spot that we pass is rendered doubly interesting — is almost hallowed — by the recollection of its being the place in which we first became acquainted with some rare or new production, which at the time awakened our curiosity, stimulated inquiry, and elicited admiration.

I cannot do better than conclude these few remarks in the appropriate language of the eloquent Vaucher: —

"I fear not to propose similar occupations to all men who have a taste for observation, and who love the beauties of nature. If their position and their fortune permits them some leisure, they cannot employ it more happily. Whenever natural history has a fixed purpose, and that some object of study is made choice of, the labours to which we submit ourselves become more agreeable, and at the same time more useful. Those botanists who shall make discoveries in this science, which presents so vast a field, not only will experience a real pleasure, but moreover they will preserve the remembrance of it. Each time that they approach the place which has been the theatre of them, it will recal to them the objects with which it is associated. For myself I avow that I see not without interest the place where I perceived for the first time the floating seeds of my *ectospermes,* nor that where I obtained the network of the *hydrodictyon* in its first development. The species of *Confervæ* even which I have long visited, and the fructification of which I have ascertained but with difficulty, inspire in me a kind of attachment which I feel more than I am able to express. I love to see spring up and develope themselves near me those species with which I am, so to speak, in acquaintance. I experience some pain if I know that any one of them come to be destroyed. This acquaintance which I have acquired seems to me a kind of empire which

I desire still to extend: I say to myself sometimes, when shall I quit the environs of Geneva? When shall I behold the borders of the sea? the Mediterranean, the Ocean? that wandering *Conferva* of which Linnæus speaks, which floats upon the sea as our *Conjugatæ* float upon the waters? I do not believe that elsewhere a happier kind of life is to be found, nor that Society furnishes to men more real pleasures than Nature affords to those who love her."

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Page 124. line 2. for "Fig. 3." read "Fig. 4."
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153. line 10. for "Fig. 1." read "Fig. 2."
154. line 10. for "ZYGNEMA ALTERNATUM" read "Z. REVERSUM."
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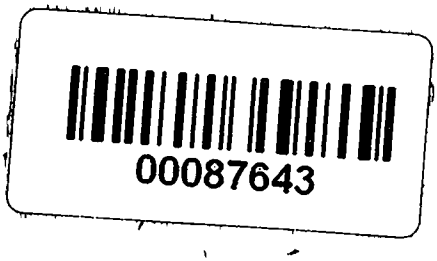
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